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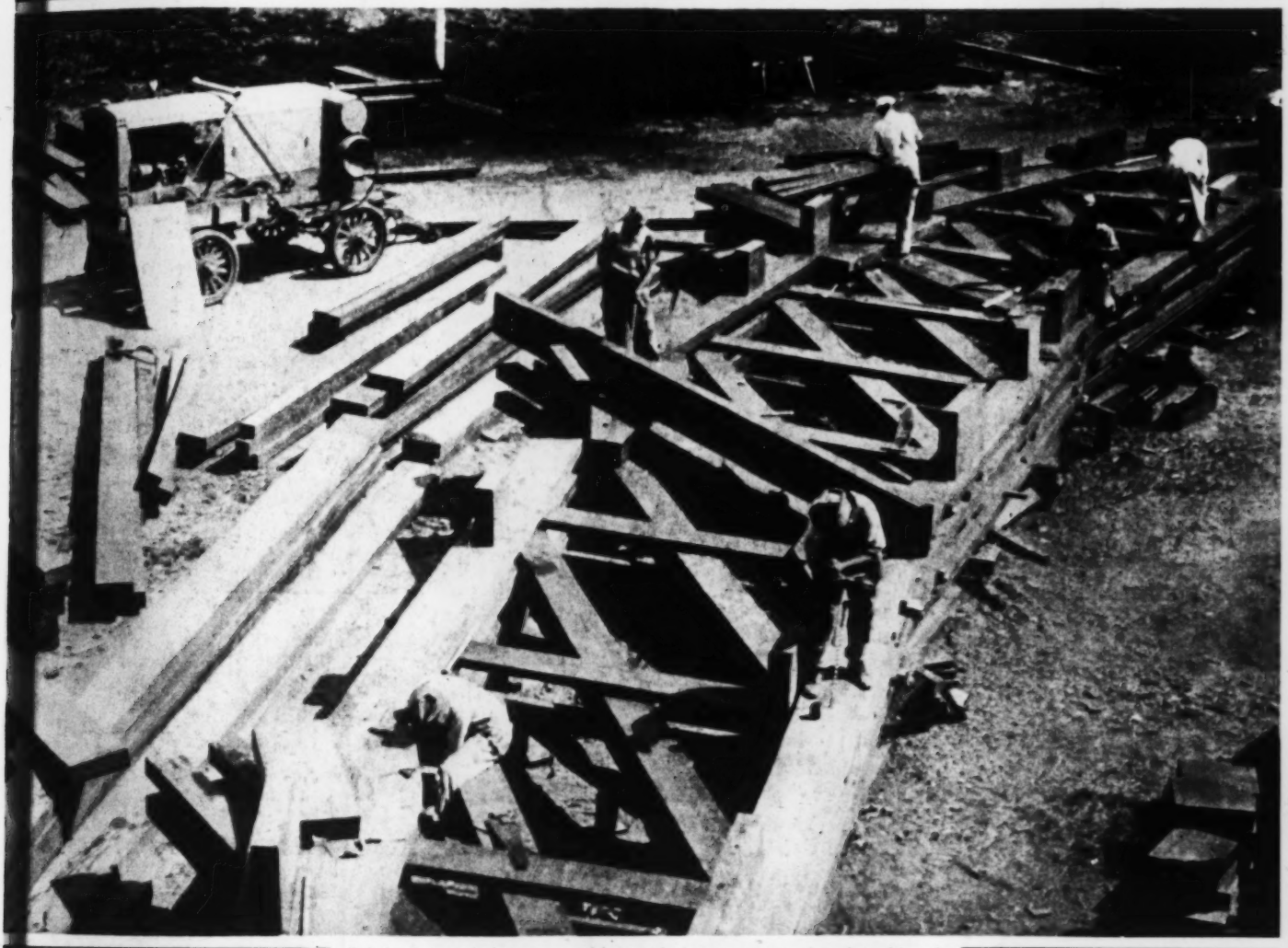

Fabricating a timber truss with metal ring connectors for three-hinged arch, of 180-ft. span on the California coast highway south of Monterey

FEATURING THE REPORT OF THE ROAD BUILDERS' CONVENTION, this issue, in addition to a full complement of articles covering bridges, dams, foreign construction, concrete technology and reviews of engineering literature, also presents the conclusions of two important federal committees on

FEDERAL RECLAMATION POLICY . . . and . . . THE NATION'S

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THE KOEHRING COMPANY of Milwaukee, Wis., checked up on every point—design, construction, performance—before it offered Koehring Shovels powered with "Caterpillar" Diesel Engines. More than a score of other manufacturers have had the same sort of Show-Down—and have adopted "Caterpillar" power. Learn the reasons why. See the Show-Down for yourself. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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DIESEL

Construction Faces a Selling Job

THIS week the writer welcomes the help of a volunteer contributor. In a night-letter to the President a Kansas City contractor gets off his chest the following comment on the new public works program:

> "Subject public works program, my interpretation of press reports indicates you propose to place 3,500,000 men at work on a day-labor basis rather than by contract. I am a general contractor and this past year I employed for a period of six months fourteen hundred men on several projects.
>
> "From an analysis of this force I find I averaged a foreman for every thirty-five men and employed six superintendents and six timekeepers in the field, not to mention the force in my general office in Kansas City such as accountants, purchasing agents, traffic men, officers of the company, etc.
>
> "Based on my own experience, in order for you to employ 3,500,000 men you would require approximately one hundred thousand foremen, fifteen thousand superintendents, fifteen thousand timekeepers and God knows how many auditors, purchasing agents, traffic men, etc.
>
> "May I ask if the present contractor's plant and equipment and his trained personnel are to remain idle while the Government begins from scratch to employ 3,500,000 men?"

Although it is quite possible that the writer of this message may have misinterpreted the President's purpose, it is decidedly worth while to ponder his statement and his question. Unfortunately, the President has found it expedient to withhold the details of his program. This can readily be understood. Were he to encourage the ear-marking of the appropriation or define too sharply his ideas on organization, he might well precipitate an orgy of log-rolling and a flock of petty squabbles that would hamstring the project.

But his silence, whether or not justified, has bred uneasiness amongst those who sense a further threat to the sorely harassed professional and industrial groups that constitute the construction industry. It may be that before this is printed all the uneasiness will have been allayed and this comment rendered ill-timed and pointless. Then again, it may not.

Possibly a ground for confidence in a reasonable outcome may be found right in the foregoing night-letter. Is it conceivable that the President will throw overboard the trained and competent staffs of governmental bureaus and those of private engineers, architects and contractors only to fumble away his resources and his more-than-precious time improvising so vast a construction organization? Is it possible that he has so soon forgotten the lessons of CWA? Is so astute a politician as the President willing to incur the risk of so colossal a failure on so vital an enterprise?

Is it not more reasonable to expect that under his exacting responsibility he will turn thankfully to, for example, the Bureau of Public Roads and the state highway departments to seek help and counsel in handling the substantial share of the funds that must go into highway improvement? Can he afford to ignore those well-established, non-federal agencies that normally carry on so much public construction? And if these agencies have a voice and a hand in the job is it not likely that they will follow their time-tested procedure of awarding contracts to qualified contractors?

To be sure, the industry would be negligent if it should take all this for granted. Unfortunately, too few outside its ranks understand its organization, special competence and the complicated and far-reaching interrelation of its various elements. To make all this clear to those in authority the industry must now do a real selling job. It must organize to do that job and it must live with the President, his advisors and with Congress until they see the truth and set up the program as it should be.

If it will thus unite the engineers, architects, contractors, subcontractors, manufacturers and others in their first major effort as an integrated industry, there is a reasonable chance that the President will come to see clearly the one sound basis upon which he can establish this greatest effort in behalf of national recovery.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 114, No. 5. Price 25c. per copy. Subscription, domestic, Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries, $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1935 by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d Street, New York; 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

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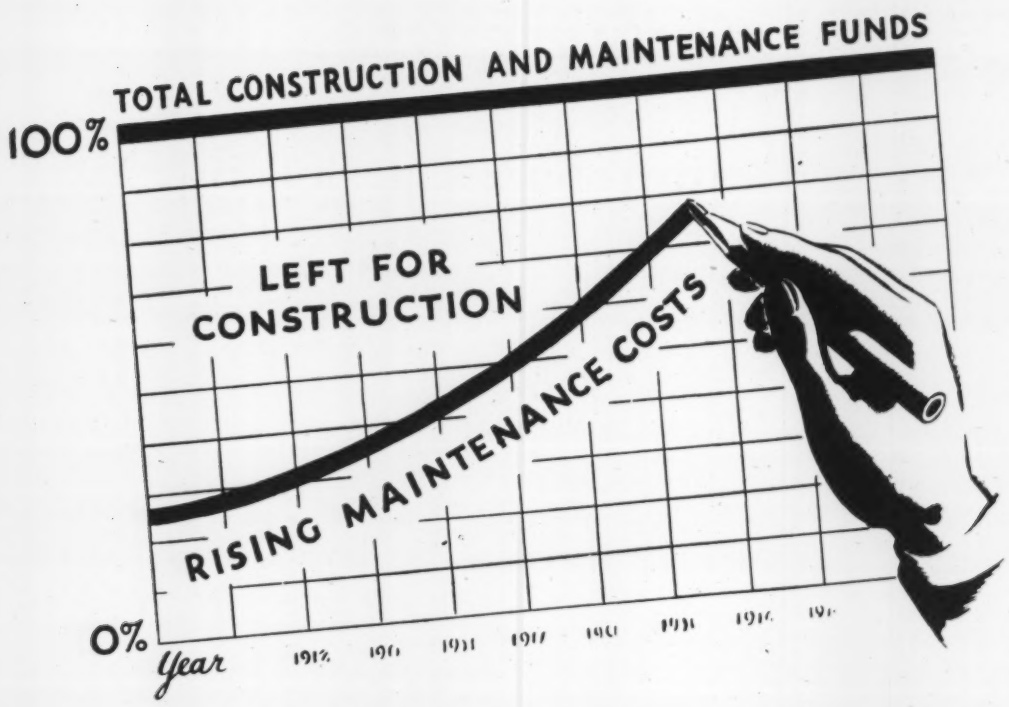
Table of Contents—See Page 17



Where these lines meet is "THE END OF THE ROAD"

HIGHWAY systems, whether county or state, cannot be loaded down with a large mileage of temporary surfacing without disastrous consequences ensuing.

Inferior, temporary highway surfaces clamor for more and more maintenance and reconstruction, year after year. Eventually, any *new* roads are out of the question. All the annual road money goes for upkeep! Then, "the end of the road has been reached," both literally and figuratively.

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CONTENTS FOR JANUARY 31, 1935

VOLUME 114 NUMBER 5 COPYRIGHT 1935

Timber Arch Uses Metal Ring Connectors... 147

Field-Testing Devices for Hydraulic Fills... 150
BY E. A. ROWE

Concrete Bridge Deck Masked With Timber. 152

Engineering in Foreign Countries..... 153

Civil Engineering in the Missouri Valley..... 155

Voids and Yield Losses in Concrete..... 156
BY J. E. BOYD

Fresh-Water Reservoir for Aquarium..... 158
BY R. LEEDOM

Report of Roadbuilders' Convention..... 160

Report of Committee on Reclamation Policy.. 167

The Nation's Water Resources..... 169

Review of Engineering Literature..... 174

Letters to the Editor..... 175

Editorials 176

Current News 178

In the News:

THE HOUSE passed President Roosevelt's $4,880,000,000 work relief bill in a form permitting him, and not Congress, to allocate the money.

NEW YORK'S BOARD OF ESTIMATE has approved a plan to borrow nearly $60,000,000 from the PWA, to build the Sixth Ave. Subway, the final link in the new Independent System.

NEW YORK OFFICIALS claim assurances from Washington that some $25,000,000 of PWA money will be made available for building the projected East River Drive from the Battery to 125th St.

THE GROWING USE of treated timber was emphasized at the annual meeting of the American Wood Preservers' Association by men from outside the association, who use large quantities of timber on railroad track and structures, in mines and in marine structures. The activities of wood borers in attacking untreated wood also were discussed.

IN SPITE OF LOCAL REPORTS indicating that authorities similar to the TVA may be established, the President has denied any immediate plans for paid commissions in other stream areas.

THE ORDER suspending the contract on the 12.7-mile San Jacinto Tunnel on the Colorado River Aqueduct has been met by the refusal of the contractor to surrender the work, and court proceedings have been started.

OPENING of the new electrified line of the Pennsylvania Railroad between New York and Washington completes one of the largest non-federal projects financed by the PWA.

FLOOD DAMAGE in northern Mississippi, at Marks on the Yazoo River resulting from record high water on the Coldwater River, continues to spread after almost a week of high water. In the Pacific Northwest, floods during the past weeks have taken 25 lives.

In This Issue:

METAL RING CONNECTORS for timber framing, which greatly increase joint capacity by carrying a large part of the load in shear, have been used in a variety of structures since they were introduced in this country about two years ago. In this issue is described a 180-ft. timber arch for which the California department of highways chose this method of framing.

AN EDITOR'S OBSERVATIONS on a trip through the states of the lower Missouri Valley reveal a relatively high degree of engineering activity and some unusual construction operations.

STUDIES OF VOIDS and yield losses in concrete by the Georgia state highway department have provided some significant results: (1) voids in set concrete are not likely to exceed 80 per cent of the volume of water used because of the amount of water used to hydrate the cement; (2) about 1.32 gal. of water is required to hydrate a bag of cement; (3) if water losses can be reduced by subgrade felt or paper, actual voids can be made to approach theoretical voids.

TESTING TECHNIQUE and procedure for hydraulic-fill dams have tended to become complicated and time-consuming with increasing knowledge of the subject, making the description of a simple field apparatus for testing on the job particularly useful for checking.

A NEW MONTHLY FEATURE, beginning this issue, will present brief abstracts from foreign-language periodicals on important developments in the field of design and construction from other countries.

THE REPORT of the committee on federal reclamation policy, appointed by Secretary Ickes last September, is abstracted.

IMPORTANT FEATURES of the Water Planning Committee report to the National Resources Board, covering the development of plans for the use of water resources, are abstracted.

A COMPREHENSIVE REVIEW of the annual meeting of the American Road Builders' Association, held in Washington last week, is presented.

THE CHIEF ENGINEER of the Greater Vancouver Water District outlines experiences in that city in maintaining a number of submerged pipe lines.

ANNUAL REVIEW NUMBER, FEB. 7

The annual survey number, appearing next week (Feb. 7), will present through statistics and authoritative articles the picture of construction during 1934 and its 1935 prospects. Included also will be notes on the status of major engineering projects.

WHEN IT'S CONCRETE

And You're SNOWED UNDER!

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ENGINEERING NEWS-RECORD

January 31, 1935

FIG. 1—A 180-FT. TIMBER ARCH, four 38-ft. timber girder spans and thirteen 19-ft. stringer spans were used for the Dolan Creek crossing on the California coast route.

Timber Arch of 180-Ft. Span Uses Metal Ring Connectors

Three-hinged highway structure over Dolan Creek on the California coast route built with timber for all stress members by use of metal connector rings

BRIDGES which the California division of highways has had to build on the coast route included one about 50 miles south of Monterey across Dolan Creek, where conditions favored an arch of either steel, concrete or timber construction. Timber was selected, and throughout the structure —in arch, girders and towers—metal connector rings were used; both the split and the toothed types were employed. Their extensive use made it possible to carry all stresses in timber members. Dolan Creek is in a relatively deep V-canyon with the grade line 130 ft. above streambed. The entire crossing consists of one 180-ft. arch span, four 38-ft. girder spans and thirteen 19-ft. stringer spans. With the exception of four lines of longitudinal steel I-beams in the floor system and other miscellaneous metal, the entire structure consists of redwood timber. A discussion of functions of the metal connector rings was published in *ENR*, March 30, 1933, p. 408, and a description of an 80-ft. truss built in Washington which used ring connectors appeared in *ENR*, July 27, 1933, page 95.

The 50-mile truck haul to Dolan Creek from the nearest railroad at Monterey and the possibility of future realignment of the highway indicated very early in the analysis of conditions at this site that timber would be preferable to an arch of steel or concrete. The next question was whether the wooden arch ribs should be made solid or laminated. Solid ribs offered some advantages on the side of framing and erecting, but inasmuch as it was desired to use an all-timber web system that would make connections somewhat more difficult with a solid rib than with a laminated rib, the latter was selected. Thus, there was a combination of conditions highly favorable to the use of the new metal ring timber connectors, and to their use is ascribed the possibility of designing a laminated arch in which all the stress-carrying members are timber. In accordance with tests which indicate that the split ring will carry about one-third more stress than the toothed ring, the split-ring type was used for all main connections; in connections of secondary importance, such as the column lacing, the toothed-ring type was employed.

A ball and socket type hinge was used at the abutments. This feature was decided upon in order that the contractor might have the option of erecting the arch rib as he pleased. That is, with an abutment hinge of this type, the arch could be erected in any position and then swung into final location, or it could be assembled in place. Although the arch ribs were detailed in such manner that the rib as a whole could be erected by panels (a plan which the designers thought would be the most convenient), the contractor thought otherwise and elected to construct each arch rib in final position, making the assembly piece by piece.

Framing yard work

As this was a federal-aid job in which there were requirements about employment for men in the county wherein the work was situated, the contractor was required to do all the framing work, such as cutting, tooling, boring holes,

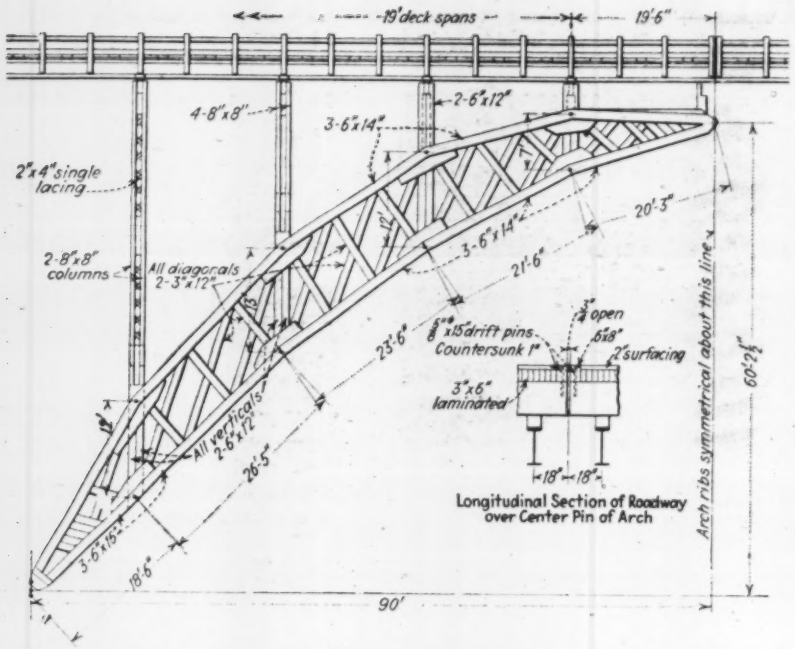


FIG. 2—HALF-ARCH ELEVATION, showing arrangement and size of main-truss members.

making daps, etc., in the same county in which the bridge is located. This work the contractor elected to do about 50 miles from the site in the city of Monterey, and here he laid out a framing yard where there was area sufficient for complete assembly of the arch ribs (Fig. 5). After assembly, of course, the ribs were taken apart for shipment to the site.

In the framing yard a base line was first laid out on the ground as the neutral axis of the rib. At points on this axis corresponding to the rib panel points, short-legged bents were constructed, all measurements being made of the size required for the finished rib. One layer of the rib chord timbers was then laid on the bents in correct position, sawed to length in place and fastened to the bents to hold it in position. This layer, supported by and fastened to the bents, became a templet for the succeeding layers. During the framing it was turned over once so that two right-hand and two left-hand ribs were made. When all the laminations had been cut to length, the complete rib was assembled with all web members, filler blocks, corbels and verticals in place, and then bored for bolting. Two man cross-cut saws were used in framing, and as each rib was laid up a cut was run through the butt joint of the chords to insure full bearing. Corbels were shaped with an adz and finished with a joiner plane. Gussets were beveled with adz and joiner. Finally the rib was knocked down, grooves were cut for the split-ring connectors, and the several parts were all carefully marked for re-assembly and hauled to the site at Dolan Creek.

In boring holes for the 3½-in. pipe shear-keys, the ordinary expansion bit was not satisfactory because the screw would walk in the joints between timbers. A special bit developed in San Francisco in 1915 for use in constructing the wood-frame buildings of the Panama Pacific Exposition was found satisfactory. The success of that type of bit was in the use of cutters on opposite sides of the horizontal bar. It is having vertical cutters and a splitting

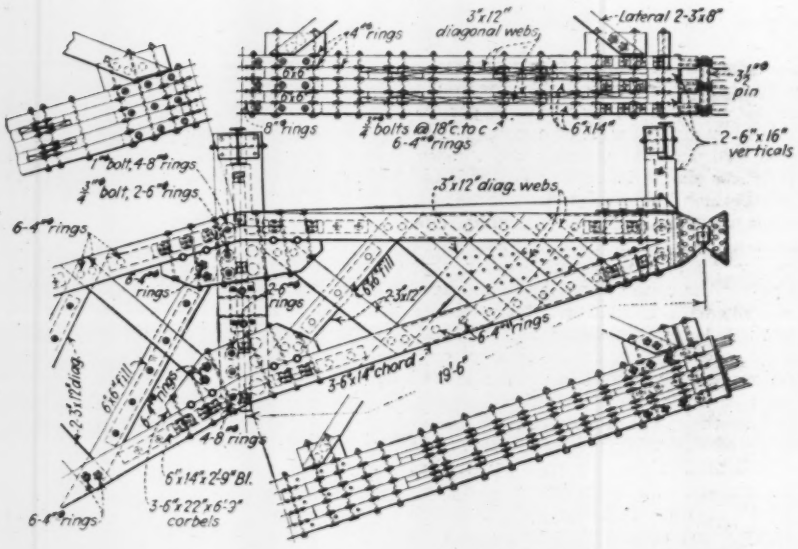


FIG. 3—DETAIL OF CROWN PANEL, showing arrangement of members and location of ring connectors.

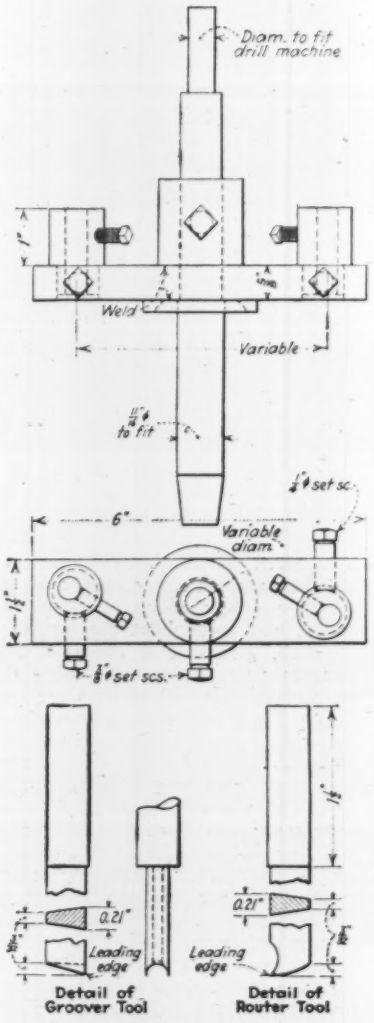


FIG. 4—RING-BORING TOOL, developed for use with ring connectors, has opposed sets of cutters.

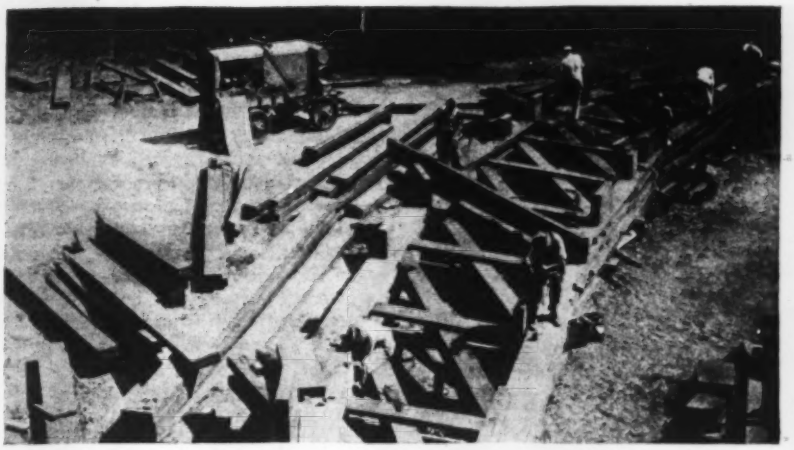


FIG. 5—FRAMING-YARD OPERATIONS 50 miles from the site, showing assembly of a complete arch rib. After framing, the parts were all marked, the rib dismantled, and the timbers trucked to the bridge site.

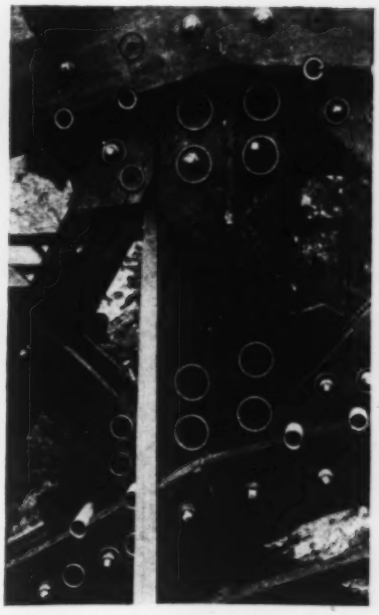


FIG. 6—SPLIT-RING CONNECTORS and pipe keys in the arch rib near the crown.

knife on either end of the bar, the operation of the bit was balanced. This bit requires that a 1-in. hole be pre-bored to center the cutters, which are mounted on a 1-in. shank.

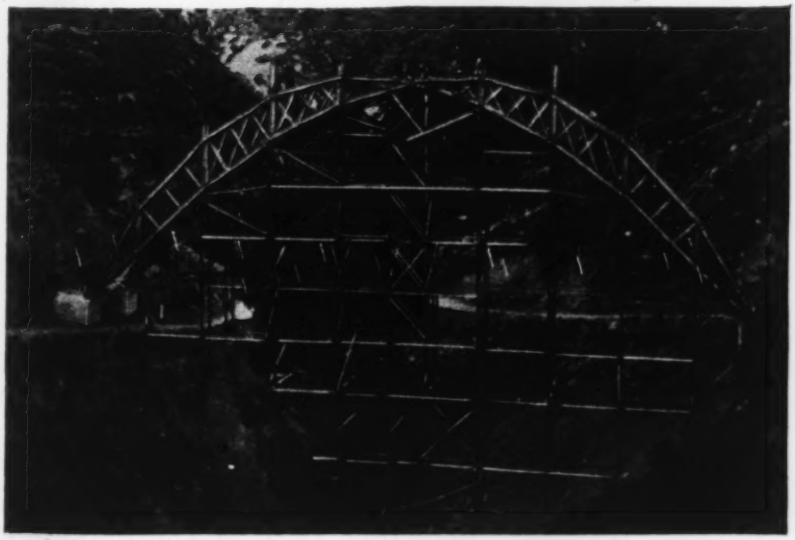
Hand-operated boring machines were tried out and proved satisfactory for starting holes accurately. Those employed on this job, however, were found to be effective only for about 18-in. depths, and deeper holes were finished by hand brace. Accuracy of boring did not seem to be bettered by using power-drill machines, although the latter would work five to eight times faster than hand-boring.

A tool for cutting the ring grooves (Fig. 4) developed by the contractor consisted of two cutter blades, one groover and one router blade. Each of the two cutters was held in an eccentric tool holder, permitting of adjustment in both directions. The groover blade was set $\frac{1}{32}$ in. deeper than the router. The grooving tool had a square shank and was operated by a hand-type compressed-air drill. The air drills available, however, were too light for this work and gave considerable trouble.

Erecting arch ribs

For erection purposes at the site the contractor installed an overhead cableway that had a capacity of 5 tons along the bridge center line. Falsework for supporting portions of the rib during the process of assembling them in place, was built up with the 3x6-in. timbers brought to the job for later use in the laminated floor of the bridge. These 3x6's were double-dressed, giving them a net section of $2\frac{3}{4}$ by $5\frac{3}{4}$, so when two were spiked together (no bolts were used) they formed posts with a section of $5\frac{1}{2}$ by $5\frac{3}{4}$ in. Four such posts constituted a bent at each of the panel points, in addition to which a central tower, consisting of two such bents, was first erected at the midpoint of the bridge. The falsework bents had horizontal ties at 16-ft. intervals vertically, but otherwise very little lateral or sway-bracing was used.

FIG. 7—FALSEWORK was erected, followed by the erection of the arch-rib timbers by means of a 5-ton cableway along the bridge center line.



With the falsework in place, the cableway began the placement of rib timbers simultaneously from both abutments working toward the center. Little difficulty was experienced in the erection of the arch rib; the individual pieces went into place with ease, and the crown arch pins were driven without undue adjustment.

Arch ribs and the columns extending above them are on a 1 to 12 batter, which is usual practice on bridges of the California division of highways, to give increased stability against wind. This accounts for the angularity of the central hinge pin as shown in the drawing.

In the bidding for this job the contractors were required to submit bids for three different items of redwood timber in place. These timber grades were as follows: (1) all timber in which ring connectors were to be used, such as chords, webbing, corbels, verticals, gussets and bracing; (2) all dimension lumber not to be used for ring connectors, such as girder and stringer span construction; and (3) bridging, scabs, posts, railing filler blocks and other miscellaneous timber. The low bid for the entire bridge was $68,000.

The contract was carried out by Rocca & Caletti, of San Rafael, Calif. C. H. Purcell is state highway engineer. F. W. Panhorst is acting bridge engineer, H. D. Stover designing engineer, department of bridges, and H. L. McCready resident engineer at the bridge.

Field-Testing Devices for Hydraulic Fills

Simple field apparatus used on El Capitan Dam, San Diego, Calif., included tool for sampling core, balance for determining water content and voids and apparatus for screen analysis

By E. A. Rowe
Engineering Offices, J. B. Lippincott, Los Angeles, Calif.

THE EL CAPITAN DAM is a combination rock and hydraulic-fill structure being built by the city of San Diego on the San Diego River, Calif. The design of the dam and methods of construction were described in *Engineering News-Record*, July 13, 1933, p. 33, by the late H. N. Savage, hydraulic engineer, San Diego. During the construction period the writer represented the engineering offices of J. B. Lippincott, consulting engineer for the contractors, H. W. Rohl and T. E. Connolly.

The city of San Diego maintained a complete laboratory for conducting physical tests of the materials incident to the construction of the dam. At this laboratory tests were made to determine the mechanical analysis of the various materials before and after being placed in the dam. Specific gravity and percentage of voids of the core materials were determined and numerous tests were conducted to determine the rate of percolation of water through the various materials. These tests were carefully and accurately made under the direction of J. Y. Jewett, in charge of the laboratory; through the courtesy of H. N. Savage the results were at all times available to the contractors. This laboratory was located in San Diego about 30 miles from the dam, and some little time was required for making these accurate determinations by the usual laboratory methods. It was found that the work of the contractors could be expedited if such determinations were available immediately as the work was being performed. Not having available any large amount of laboratory materials, the writer devised simple equipment that could be constructed of the materials at hand, by the use of which fairly accurate determinations could be made within a few minutes after sampling.

Core-sampling device

The most important requirement was knowledge of the character and condition of the puddle core. To make these determinations, it was necessary to obtain samples of the materials at various depths. During the early period of the work numerous sampling tools were built and tried. The use of these earlier sampling tools was not altogether satisfactory. In most cases the sample obtained was disturbed and not in the same condition as it existed in the dam. All of these tools required considerable time and labor in their use. After they had proved more or less unsatisfactory, the writer constructed the sampler shown by Fig. 1. This tool is simple in operation, easy to construct, and by its use undisturbed samples of puddle core can be quickly obtained. Cores can be cut out of the puddle core at any desired location and depth, limited only by the length of the tube. After its construction it was used entirely by the engineers of the city of San Diego and the contractors in taking over 3,000 samples from the puddle core of the El Capitan Dam.

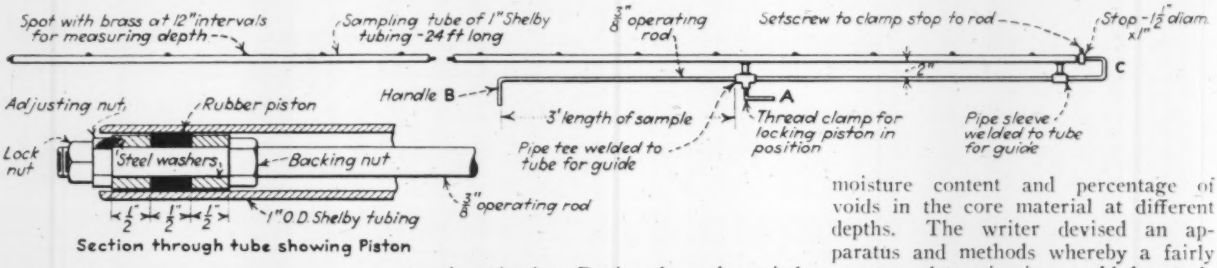


FIG. 1—SAMPLING DEVICE for obtaining samples of the core material in the El Capitan hydraulic-fill dam at San Diego.

In using the sampling tube the operating rod is pulled down to the position shown in Fig. 1. Clamp *A* is then locked, holding the piston in position at the lower end of the tube, as shown in the enlarged section. The tube is then lowered in the summit pool to the required depth, as indicated by the brass spots welded on the outside. Clamp *A* is then released and, holding the handle *B* of the operating rod in a fixed position, the tubing is then shoved into the core material until the handle *B* engages with the guide at the clamp *A*. Clamp *A* is then again locked and the tube is withdrawn from the pool and the core is obtained by laying the tube horizontally and bracing the U-end of the rod marked *C*, releasing clamp *A* and pulling the tube back until the piston reaches the end of the tube. After a period of use the rubber piston will become loose and can be tightened by operating the adjusting nut at the lower end of the rod.

Moisture-content device

The rate of consolidation of the core material in the El Capitan Dam was determined by the usual method of lowering a 6-lb. weight in the summit pool and measuring the depth at which it came to rest. This method is only of value to compare the condition at a given time with that at some previous time. Authorities agree that the best index of consolidation and stability can be had from a determination of the moisture content and percentage of voids in the core material at different depths. The writer devised an apparatus and methods whereby a fairly accurate determination could be made easily and quickly. The results by this method are based on a constant specific gravity of the solids. The engineers of the city of San Diego in their testing laboratory made many determinations of the specific gravity of the core material in the El Capitan Dam. The results of these studies indicated the specific gravity to be very constant, ranging from a minimum of about 2.27 to a maximum of 2.78. The apparatus was therefore designed to determine the moisture content and voids based on a specific gravity of the solids of 2.75. For materials having such a uniform specific gravity, as indicated above, the use of the constant of 2.75 would not result in substantial error. The apparatus used is shown by Fig. 2.

A piece of Shelby tubing of the same diameter as that used in constructing the sampling tube and about 8 in. in length was plugged with steel at one end to form a cup. In the bottom of this plug a small hole was drilled to release the air as the sample was being placed therein. The core material was sampled with the sampling tube described above. Before driving the sample from the tube, a short length of pipe having an internal diameter slightly larger than the exterior

diameter of the sampling tube was slipped over the end. The cup B was then inserted in the end of this larger pipe and brought up to about the end of the sampling tube. The operating rod of the sampling tube was then slowly pulled down, forcing the sample into the cup B. When the cup was filled, the top was struck off level, and the small vent hole in the bottom was sealed by applying a small amount of stiff core material. A hanger of spring steel wire was then attached to the top of the tube, and it was suspended upon the balance as indicated in Fig. 2.

This balance consisted of a piece of steel 32 in. long and $\frac{3}{8}$ in. square. It was uniform in section throughout, and its use for this purpose gave substantially accurate results. Slight notches were cut in the top edges of this rod 15 in. each side of the center, as determined by balancing. The knife-edge was made by grinding a three-cornered file. On one end of this balance was suspended a weight A (Fig. 2), which was exactly equal to the weight of the cup B filled with water. After the cup B had been filled with the sample as described above, it was suspended on the other end of the $\frac{3}{8}$-in. rod and moved to balance exactly the weight A. The end of the rod on which the sample was suspended was graduated, so that the percentage of moisture in the sample could be read directly. These graduations were etched on the side of the rod and were computed from the following formula:

W = weight of cup B when filled with water = weight A.
W_1 = weight of cup B when empty.
v = internal volume cup B.
x = volume of solids in sample.
2.75 = specific gravity of solids.
a = unit weight of water.

$$15W = y\,(W_1 + 2.75\,ax + av - ax)$$
$$= y\,(W + 1.75\,ax + av).$$
$$y = \frac{15W}{W_1 + 1.75\,ax + av}$$

The writer checked the results obtained by use of the above methods by the customary method of weighing and evaporating, and the variance was not more than 4 per cent, which was probably less than the errors in sampling.

Screen-analysis device

Fig. 3 shows apparatus and methods used by the writer in making screen analyses of the puddle-core material. By using this method the percentage by weight passing different screens could be determined in a few minutes. The results obtained checked closely with the analyses made by standard methods in the laboratory of the city. The difference was not more than 2 to 3 per cent, which could very easily obtain in the samples tested.

It is not necessary to have a definite quantity of material to analyze. With the apparatus shown the best results could be obtained with about half a pint of material. The sample was obtained by the use of the sampling tube shown by Fig. 1. The sample was then placed in the container A, Fig. 3. This container was made from a pint fruit jar having a special dome-shaped top with a short length of tubing about 1 in. in diameter on the top. The purpose of the dome-shaped top and the tubing is to release any confined air and more accurately fill the container with water. After the sample had been placed in the container, the top was screwed on, and some water was then added. It was then shaken, to be sure that the material was thoroughly saturated. Water was added to fill the container to the top of the tube. The container was then suspended on one end of the balance, as has been previously described.

At the other end of this balance exactly the same distance from the center was suspended a weight B equal to the weight of the container A when filled with water. On this same side of the lever arm was suspended a sliding weight C. As used by the writer, this weight was 1 in. square and about 2½ in. long. It had a square hole accurately cut through the center, through which was passed the balance rod. After the sample was suspended on the balance and the weight B attached as indicated, the sliding weight C was moved until the weights and container exactly balanced. The distance X was then measured. The sample was then removed from the container A and washed through a screen of the desired size. This was done by spraying it with a small jet of water sufficiently long to insure all of the fine material being washed out.

The material that was retained on the screen was again placed in the container A, which was then filled with water to the top of the tube. In making these transfers care had to be taken that none of the material escaped except

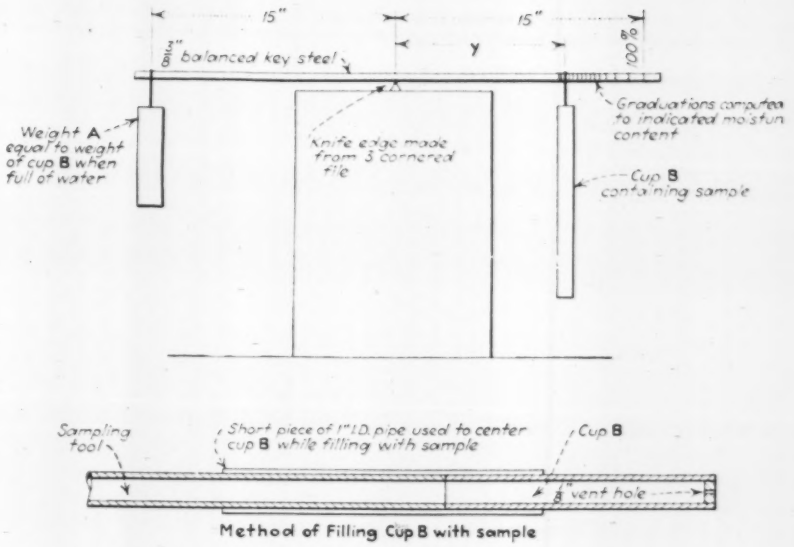

15"
15"
y
⅜" balanced key steel
Graduations computed to indicated moisture content
Weight A equal to weight of cup B when full of water
Knife edge made from 3 cornered file
Cup B containing sample
Sampling tool
Short piece of 1" I.D. pipe used to center cup B while filling with sample
Cup B
⅛" vent hole
Method of Filling Cup B with sample

FIG. 2—WATER CONTENT AND VOIDS in core material of El Capitan Dam determined by simple field balance.

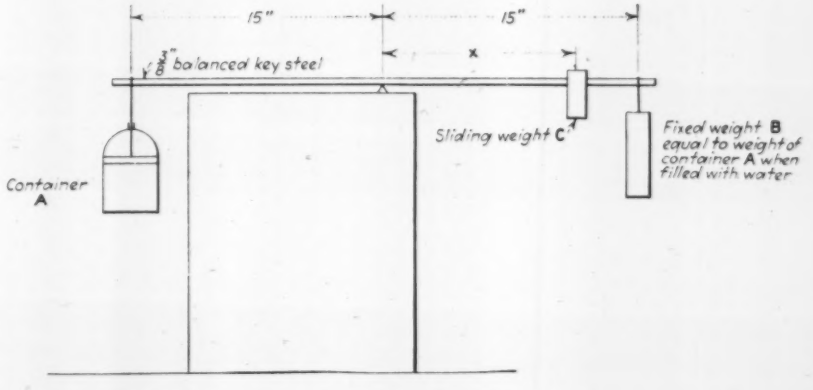


FIG. 3—SCREEN TEST of core materials in El Capitan Dam given by balance and simple computation.

that washed through the screen. The container was again suspended on the balance, and the sliding weight *C* was moved until all of the weights balanced. The distance *X* was then again measured. The ratio of the distance *X* as last determined to the distance *X* as first measured, is the percentage of weight of the material retained on the screen.

The only possible chance for error in this method would be that the specific gravity of the material washed from the sample would be different than the average for the entire sample before screening.

Concrete Bridge Deck Masked With Timber for Rustic Appearance

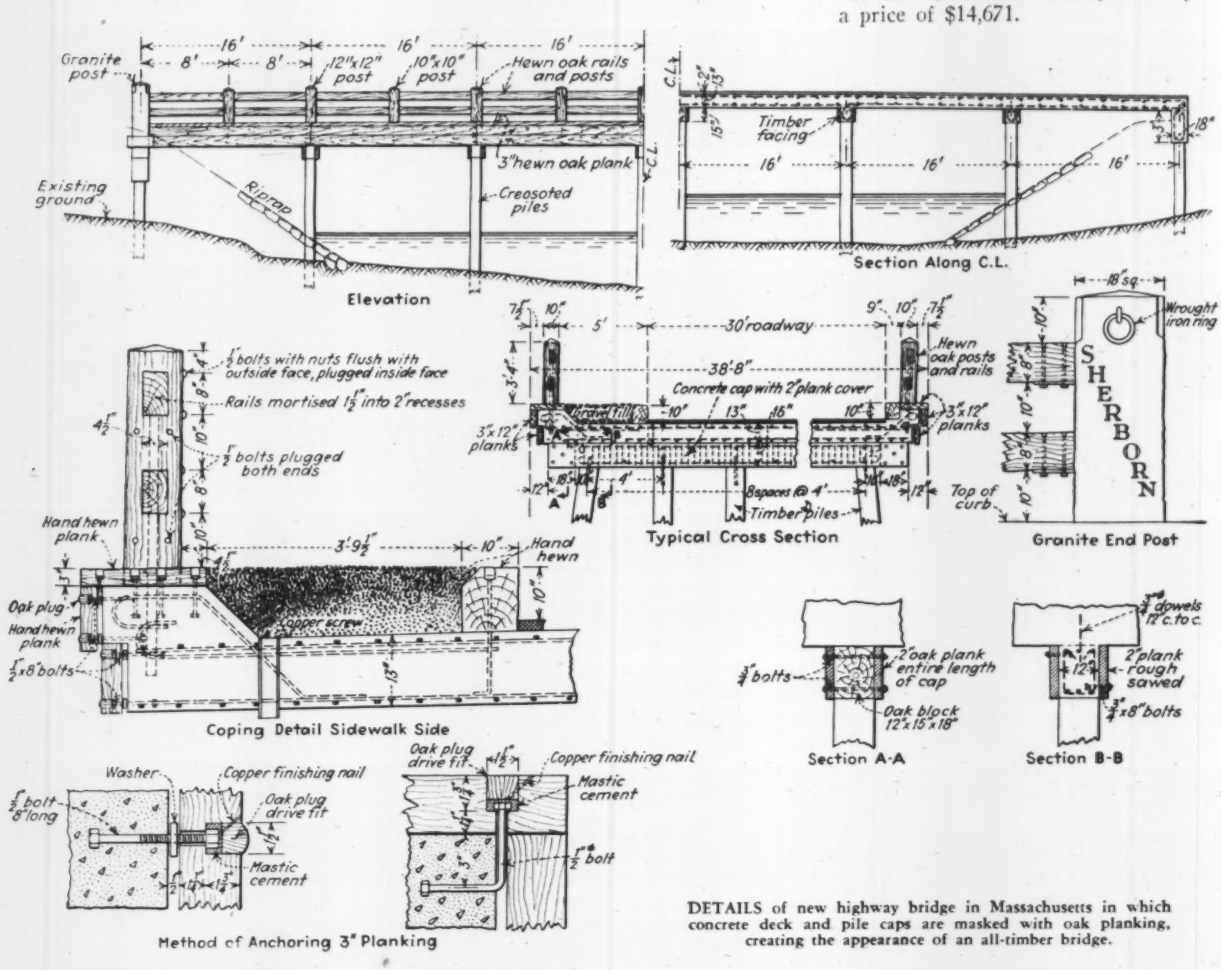
A NEW BRIDGE under construction across the Charles River between Dover and Sherborn marks an attempt by the Massachusetts department of public works to utilize a design that is in keeping with the locality in which the structure is located. In this instance the banks of the stream are wooded, and most of the near-by residents occupy large country estates. A timber structure seemed most suitable, but a concrete deck was desired. The structure utilized satisfied both requirements by masking the concrete copings with rough-hewn red oak planking. A railing of the same type of timber was also used.

The bridge is made up of six 16-ft. spans on creosoted pile bents, nine piles per bent. Pile caps are reinforced-concrete beams 15 in. deep and 12 in. wide. The deck is a 13-in. reinforced-concrete slab, 35 ft. 9 in. wide between handrails, providing a 30-ft. roadway and a 5-ft. gravel-fill sidewalk. Curbs are 10-in.-square timbers. A 2-in. bituminous surface is used on the roadway.

The use of hand-hewn red oak for railing and facing material constitutes the most interesting feature of the bridge. Posts in the railing, set at 8-ft. centers, are 12x10 in. in section at the bents and 10x10 in. at intermediate points. The posts rest on a 3-in. plank 18 in. wide, running the full length of the bridge on the top of the deck coping. The end posts are of granite with the town names "Sherborn" and "Dover" cut in. These end posts are made to resemble old-fashioned hitching posts even to the use of the wrought-iron hand-forged ring. Fence rails are 8 in. deep and 4½ in. wide, mortised into the vertical posts.

Facing planks are used for the full length of the coping and also on both sides of the concrete cap beams over the pile bents. Details are shown in the accompanying illustration. Planks are anchored to the concrete by bolts in counterbored holes, which are plugged with tight-fitting oak plugs covered with marine glue. The resulting appearance is that of an old New England timber bridge.

The bridge was designed by the Massachusetts department of public works, of which A. W. Dean is chief engineer and George E. Harkness bridge engineer. The bridge is being built by the Lee Construction Co., Boston, at a price of $14,671.



DETAILS of new highway bridge in Massachusetts in which concrete deck and pile caps are masked with oak planking, creating the appearance of an all-timber bridge.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

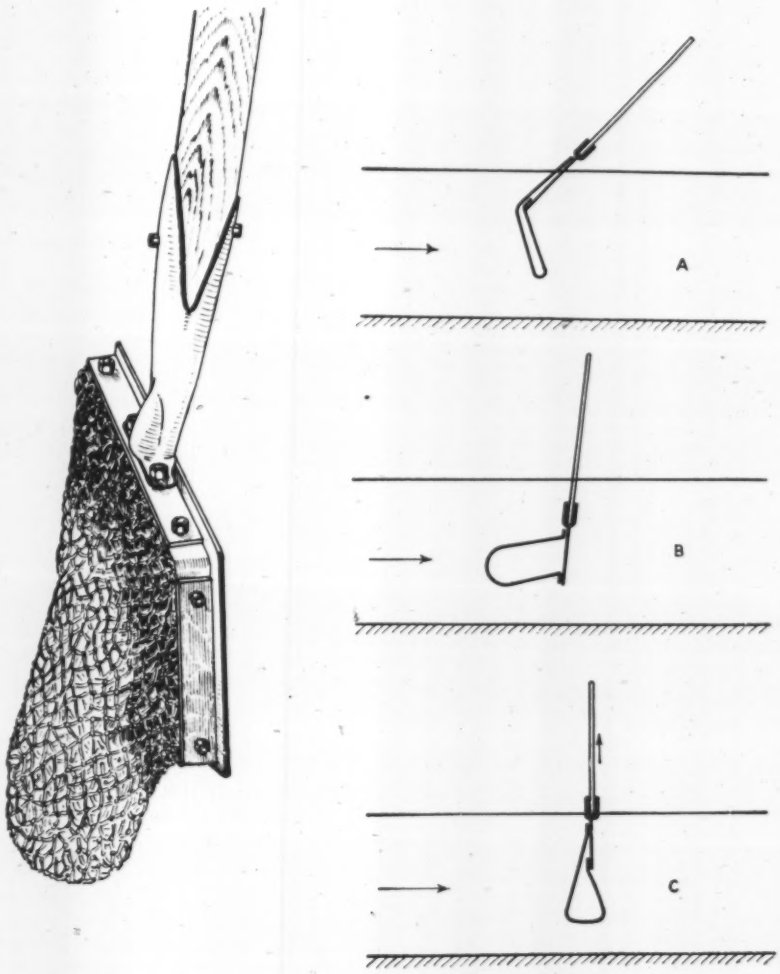
TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, it is planned to publish monthly a small group of short abstracts of articles and papers published in other languages than English. In these abstracts no attempt will be made at a compendium of foreign-language articles; selection will be made only of articles which emphasize some procedure or invention in engineering practice that has general interest or usefulness. Selection from each article will also be confined to the part or parts of special novelty or significance—a unique design or construction method or a striking determination by experimentation. For the reader who wishes to have the more extended description or discussions, the author and source of the original article will be given by name and publication dates. The contacts with foreign engineering activities that these summaries and references make possible should have value to American engineers.—EDITOR.

Bag-type sewage sampler

Samples to determine the percentage of suspended solids in sewage are generally taken with a metal bucket. It has been found that when a rigid bucket is lowered into a stream of sewage, generally running with a velocity of 2 to 3 ft. per second, complex eddies are induced which tend to divert solid particles heavier than water, and as a result, the sample will test low, i.e., it will show a solids content lower than is correct.

To correct this error of sampling, the department of sewage disposal of Munich, Germany, has developed a collapsible sampler which in its general appearance is not unlike a net for catching butterflies. As described by H. Keppler in *Gesundheits-Ingenieur*, April 28, 1934, this sampler consists of a rod carrying a metallic rim provided with a sack of 1.2-gal. capacity, made of a waterproof batiste material, backed with a net of coarse yarn. As shown by the accompanying illustration, when sampling, the immersed end is first pointed obliquely upstream, then the rod is held nearly vertical and the sampler is dragged downstream for 4 or 5 ft., with a velocity slightly greater than that of the stream, whereupon the originally collapsed sack opens up and fills with sewage. When pulled out in an upward direction, the mouth of the sack tends to close again.

Comparative tests of the orthodox metal bucket and the new collapsible-sack sampler involving 2,160 raw sewage samples taken fifteen times daily for nearly one year, showed an average increase of 17 per cent (2.88 instead of 2.46 cc. per liter) attributable to sampling with the collapsible sack. In the case of sewage previously subjected to sedimentation, a similar test showed an increase of only 3 per cent.



BAG-TYPE SAMPLER and sampling procedure employed at the sewage works at Munich, Germany.

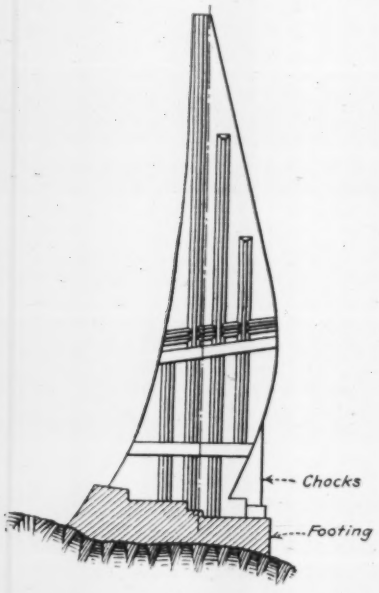
Marèges concrete-arch dam

A concrete-arch dam 295 ft. high is being built on the Dordogne River at Marèges, France, by the Orleans Railroad Co. This dam will form a storage reservoir of 26,000 acre-ft., to utilize the runoff of a watershed of 965 square miles, yielding an average of 2,300 sec.-ft., for the generation of electric power for railroad electrification. The dimensions of this dam, which is a single arch resting on a natural granite foundation, are given in an article by J. Dumas in *Le Génie Civil*, July 7, 1934, as follows:

Maximum height, ft.	295.3
Length of arch crest, ft.	650
Thickness at crest, ft.	9.8
Thickness at base, ft.	62.3
Radius of extrados at crest, ft.	328
Radius of extrados at base, ft.	262.5
Radius of intrados at crest, ft.	318.2
Radius of intrados at base, ft.	82
Total volume of concrete, including spillway and gravity section, cu.yd.	242,000
Average compression stress, lb. per sq.in.	356
Maximum compression stress, lb. per sq.in.	782

The original feature of this dam is its cross-section, which is so proportioned as to cause the dam to lean upstream when the reservoir is empty, thus prestressing the upstream face of the dam in compression, which stressing is turned to favorable account when the reservoir is filled and the upstream face of the dam

is stressed in tension. Furthermore, to minimize the disadvantages of the fixed cantiliver condition generally obtaining at the base of arch dams, "chocks" and "crutches" have been provided. The "chocks" are wedge-like concrete blocks, not forming part of the arch structure, which are built along the foundation footing. The "crutches," on the other hand, are miniature buttresses, rigidly attached to the body of the dam, which rest on the "chocks." When the reservoir is filled with water, hydrostatic pressure lifts the dam off or away from the chocks, thus diminishing the fixedness of the dam



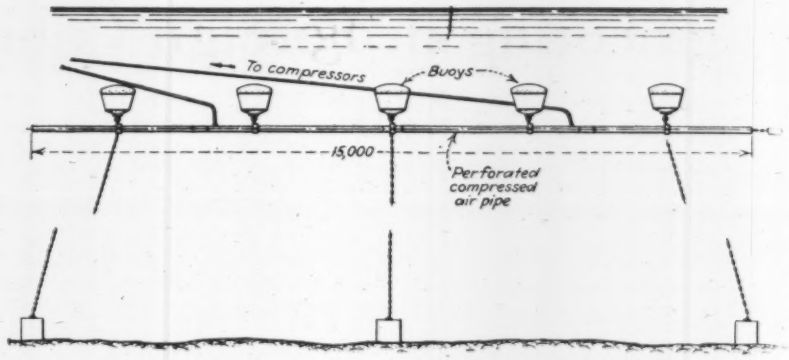
MAREGES DAM SECTION for hydro-electric plant of the Orleans Railway on the Dordogne River, France.

cantilever. These provisions are expected to eliminate secondary stresses and the consequent danger of crack formation on the upstream face.

To insure continuity of arch action, a monolithic footing, about 30 ft. high, supports the middle and western thirds of the arch. Above the footing, the entire length of the arch is divided into fifteen voussoirs separated by expansion joints.

The concrete placed in the arch footing and in the expansion joints is of extra-rich composition—about 460 to 505 lb. of cement per cubic yard of concrete. The rest of the structure is built of concrete containing about 425 lb. of cement per cubic yard of concrete, with a water content corresponding to a water-cement ratio of 0.68. The average compression strength of this concrete at 90 days is about 3,414 lb. per sq.in.

The west end of the arch adjoins a rectilinear section of gravity profile, 160 ft. long surmounted with three spillway sluices of 24.6-ft. clear span each, 16.4 ft. high, having a total discharging capacity of 24,700 cu.ft. per second. These open spillways are supplemented with two



PNEUMATIC BREAKWATER installed at Sebastopol on the Black Sea, Russia.

tunnel spillways, 26.2 ft. in diameter, at the east abutment of the arch, which are provided with two sluices, 39.4x36.1 ft., discharging a total of 70,600 cu.ft. per second with a velocity of 75.5 ft. per second. These four spillways together with the penstocks and scouring sluices will have a total discharging capacity of 106,000 cu.ft. per second, which is twice the discharge of the greatest flood observed on the Dordogne at this point.

Pneumatic breakwater experiments

The idea of the pneumatic breakwater, which was originally tried out in Atlantic City and other American ports about 25 years ago, has recently come to life in U.S.S.R. Two studies with models were made in a Leningrad hydraulic laboratory, and one experimental installation was tested in the port of Sebastopol, on the Black Sea, in the summer of 1933.

A pneumatic breakwater disturbs the oscillatory rhythm of a wave and thus damps it, by means of jets of compressed air projected upward from subaqueous perforated pipes. In the Leningrad hydraulic-model experiments, waves as high as 1.15 ft. were completely damped with jets of compressed air, and quantitative design data were determined.

The Sebastopol installation, as shown by the illustration from an article by S. R. Lieberman in *Vodniy Transport*, July and August, 1934, consisted of: (1) a battery of four portable air compressors with a total output of 1,236 cu.ft. per minute: (2) lines of hose with a control chamber; and (3) four parallel pipes, 3.94 in. diameter, 49.2 ft. long, anchored at a depth of 16.4 ft., and one pipe of the same length and diameter anchored at a depth of 32.8 ft.

All pipes were perforated with holes, about ¼ in. in diameter, spaced 6 in. apart. The pipes were anchored with three weights and buoyed with five buoys. Most of the pipe installation was assembled on shore and sunk by a floating 50-ton crane, divers making the final adjustments.

Observations made in August, 1933, showed that waves as high as 4.3 ft. were reduced to a height of 1.0 to 1.3 ft. immediately after crossing the line of the pneumatic breakwater. A reduction of 60 per cent in height was generally observed, as well as an increase in the period of the wave. The pressure in the control box was about 38 lb. per sq.in., and air was issuing uniformly from all the perforations. The results seem to justify further studies of the subject.

Russian engineers estimate the cost of the pneumatic breakwaters at 10 to 50 per cent of the cost of a masonry structure serving the same purpose. They are considered particularly advantageous in ports of limited space, or with narrow entrances, also where a free run of ice is essential; and they may prove useful as temporary protection in the execution of marine works.

Voids in rubble breakwaters

Realizing that there are practically no data on the percentage of voids in rubble mound breakwaters, the Central Research Institute of Water Transportation of Leningrad, U.S.S.R., had tests made using 1:50 models representing prismatic concrete block prototypes having blocks weighing 41 to 44 tons. As described by G. F. Ostasevich in *Sbornik Nauchno Issledovatelskikh Materialov* CNIVT, Leningrad, 1934, the block models, whose maximum dimensions were about 3.15x1.77x1.65 in., were dumped freely to form embankments of trapezoidal cross-section, with 1 on 1 or 1 on 1½ slopes, ranging from 7.5 to 13.4 in. in height (representing prototypes 31 to 59 ft. high). The total volume of voids in such fills was found to range from 41.7 to 42.8 per cent. The average of six determinations was 42.2 per cent. Five determinations of voids in similar embankments with blocks placed more compactly (method of placing not stated) showed from 39.7 to 40.7 per cent and averaged 40.2 per cent of voids.

The results of this series of determinations indicate voids far above the assumptions usually made, which range from 25 per cent (Algiers breakwater, 1838) to 33 per cent (Odessa breakwater, 1913) and were generally found wanting when put to the test of practical experience.

Civil Engineering in the Missouri Valley

Omaha, Jan. 15.

FROM St. Louis to Fort Peck, the Missouri River Valley is responding to the vitalizing force of construction. Like construction everywhere, it is largely public construction; but its major part reflects a normalcy not always associated with contemporary work.

In Kansas City this feeling of normal activity is particularly apparent. One gets a glimpse once again of busy—if not overloaded—engineering and contracting offices, for Kansas City is the focal point of nearly all valley work. The Fort Peck Dam design and direction originate in the United States Engineer office there. The four contractors who joined forces to build the Fort Peck spillway are located there. The Missouri River stabilization program from St. Louis to Sioux City centers there, and the river contractors have offices there. Kansas City engineering firms have designed and are directing many, if not most, of the municipal PWA projects in Kansas and Missouri which require consulting services. Finally, the local-government units have not been idle, and notable structures built by contract attest to the fact. A new skyscraper-type court house for Jackson County, fourteen stories and 293 ft. high, was dedicated with great ceremony at the year end. The last roof trusses on the huge block-square municipal auditorium are being set in place, and wall-enclosure operations are close behind. In the block immediately north of the new court house some 1,500 relief workers have begun hand excavation for the city's new 32-story city hall; contract work will rule on this job as it did on the auditorium after the rough general excavation is finished.

Kansas City work is varied

Engineering activity in Kansas City thus is visible as well as vigorous. It is also varied, for added to the above-described types of work there is highway and bridge work in the vicinity. Across the Missouri River in North Kansas City the state highway department is finishing an approach road to the new Regional Bridge, to be opened soon, while across the Kaw, in Kansas City, Kan., riveting hammers will soon be heard on the $1,900,000 high school, to accommodate some 2,000 pupils. The Kansas highway department is building a viaduct in the Fairfax industrial district, to connect the Seventh St. Trafficway (*ENR*, Oct. 19, 1933, p. 459) with the Regional Bridge. Studies are being made for increasing the vehicle capacity of the Inter-City Viaduct by removing the car tracks and strengthening.

Kansas City overshadows other cities in the valley, but it by no means has a monopoly on all construction. In St. Louis the Missouri highway department is building a $600,000 depressed highway through Forest Park involving 2 miles of 50-ft. pavement and nine grade-separation structures. This new road connects U. S. Highway 40 with the city boulevard system, but civic-minded persons in St. Louis are already casting about for ways and means to extend it entirely across town to the Municipal Bridge over the Mississippi River. The highway department has plans for a $7,000,000 state-wide grade-separation program for 1935 if funds can be obtained. Also a $14,000,000 program of modernization for state and eleemosynary institutions has just gotten under way.

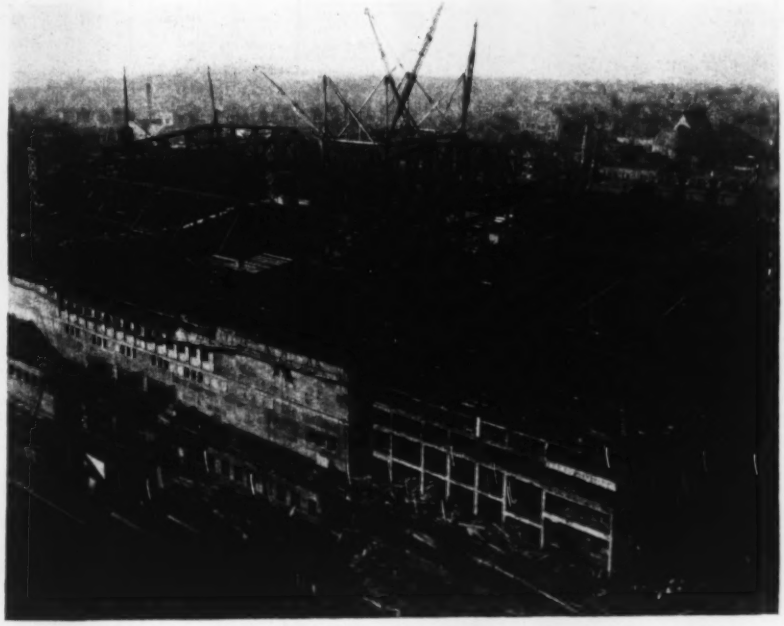
Missouri River work between St. Louis and Kansas City is practically complete, but the stabilized channel needs water before navigation is possible. Between Kansas City and St. Joseph, also, a new 6-ft. channel will be available with a normal river rise.

Fort Peck spillway models

At Gasconade, Mo., where the government boat yard is located, notable model tests of the Fort Peck spillway have recently been concluded. Two models on scales of 1:25 and 1:36 were tested, with significant results. For one thing, training walls below the gates were shown to be unnecessary, and were eliminated from the design—an important saving. For another, it was shown that the gates must be opened symmetrically, else standing waves that will overtop the spillway channel are created.

The Mississippi Valley Committee's recommendation of storage dams on the Republican and Blue Rivers in central Kansas gave rise to much discussion in the lower Kaw valley and in Kansas City, where sentiment has favored the great Kiro Dam project just west of Topeka. Control of Kaw River floods is basically of more concern to Kansas City than to the Kaw Valley itself, for the levees around the industrial district are not high enough to withstand another 1903 flood. The Kiro Dam would require no raising of the levees, while some raising would be necessary if the Blue and Republican River dams should be built. Discussion of Kaw River flood control, however, is largely wishful thinking under present conditions, wherein the federal government will pay construction costs only up to federal benefits. Neither Kansas City nor the valley land owners have indicated a willingness to finance their shares, although plans are under way to create a bi-state conservancy district by legislative acts as a first step.

Full-size welded plate girders have been built and tested recently by both the Missouri and Kansas highway departments. Results were significant



MUNICIPAL AUDITORIUM AT KANSAS CITY APPROACHES AN AUGUST COMPLETION DATE.

This huge structure, 425x330 ft. in plan, consists of a 3000-seat theatre (tier framing at right end) and a 14,000-seat concrete auditorium, over which an elaborate system of heavy steel roof trusses is being erected. This trussed-roof system, covering an area 225x200 ft., is supported on only four columns and is completely separated from the rest of the structure.

both in strength and low cost, but until the Bureau of Public Roads changes its present attitude on welding there is little chance to utilize them.

Missouri River channel work

River work in the Missouri Valley is concentrated between St. Joseph and Omaha, although some $2,000,000 is being spent on work between Omaha and Sioux City. Of the $18,000,000 allotted to the Omaha district for work between St. Joe and Omaha about 40 per cent has been spent. Progress has been hampered by low water, which slows up dike construction and brings channel-cutting action to a virtual standstill. This latter condition is a serious consideration on the South Omaha bridge project now under construction. Coincident with construction of this mile-long structure, which is progressing from west to east, the army engineers are moving the river channel some 2,000 ft. westward, so that it will be under a 1,050-ft. two-span continuous truss. Bridge piers have been built on land, and steel erection is rapidly approaching the present channel, which is still about 1,000 ft. east of its final location. Unless more water comes down the river to cut the new channel faster, the bridge may have to be left unfinished for a time, for the present channel cannot be blocked by the low approach spans, which would keep river contractors' boats from moving.

The South Omaha Bridge, a toll structure being built with PWA funds by a city bridge commission, affords a direct connection between Iowa livestock territory and the Omaha stockyards. It also permits bypassing the Omaha business district and eliminates nineteen railroad grade-crossings.

Along the Platte River tributaries are located the two great irrigation and power projects that account for $15,000,000 of Nebraska's $20,000,000 PWA appropriations. The Sutherland project on the North Platte is 50 per cent under way, while the Columbus project on the Loup River is about 30 per cent.

PWA work in the Missouri Valley states of Kansas, Missouri and Nebraska is practically at its peak, more projects being under construction than are available for future contracting. All states want grade-elimination work. On the other hand, large-scale housing is never mentioned in this part of the country. Even subsistence homesteads get little attention or sympathy. The CCC receives high praise, as does the PWA after respects have been paid to some of its red tape details. The relief problem in the cities is still acute, and more employing jobs are needed; smaller communities are venturing to suggest that they would like to see an end to FERA and a return to local handling of relief. In these views, again, may be glimpsed the beginning of a trend toward normalcy in thinking and activity. —W. G. B.

Voids and Yield Losses in Concrete

Tests indicate that voids in set concrete will not be likely to exceed 80 per cent of the volume of water used—Full 100 per cent volume yield not obtainable in practice

By J. E. Boyd
Testing Engineer,
Georgia State Highway Dept., Atlanta, Ga.

BLANCHETTE, in his excellent treatise, "Some New Relations Bearing on Concrete Mixtures," (*Public Roads*, May, 1934) shows voids in concrete equal to the volume of water used plus the volume of entrained air. In fact, it is common practice in yield computations to assume that the volume of water used will produce the equivalent volume of voids. However, Blanchette deals with fresh concrete, where water is yet water and not voids. The voids in set concrete will not be likely to exceed 80 per cent of the volume of water used because of the amount consumed in the hydration process.

Water for hydration

To compute the theoretical voids in hardened concrete, it is essential to know the amount of water consumed in the hydration of the cement. In the laboratory of the Georgia state highway department hundreds of briquettes were made of neat cement of normal consistency, stored in moist air at 70 deg. F. for 24 hours and then in water at 70 deg. F. At various ages, ranging from three hours to one year, three briquettes for each age were dried at 110 deg. C., pulverized, sieved through 100- and 200-mesh sieves, and redried at 110 deg. C. to constant weight.

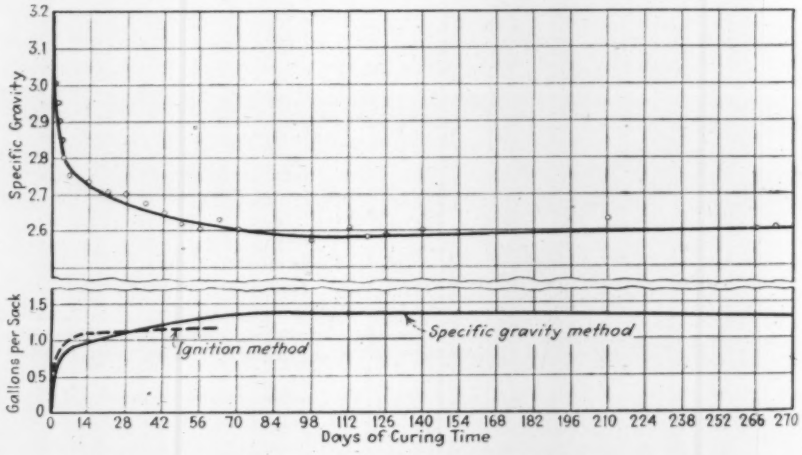
The specific gravities of both 100- and 200-mesh particles were determined, showing a rapid decrease from the original specific gravity of the dry unhydrated cement for about seven days, after which hydration or reduction in specific gravity progressed very slowly. There was very little difference between the specific gravities of the 100- and 200-mesh particles.

The volume ratio of water to cement was computed by the formula $a.x + b(1.00\text{-}x) = r$, where a is the specific gravity of water, b is the specific gravity of fresh dry cement, x the parts water, $1.00\text{-}x$ the parts cement, and r is the specific gravity of hydrated cement.

Per cent by weight is computed by the formula $100\,\frac{(bx)}{r} = y$ or $100\,\frac{(ax)}{r} = y$, where y equals per cent by weight. From the percentages by weight, the pounds of water combining with 94 lb. of cement are computed by simple proportion and converted to gallons.

This determination of combined water was closely checked by determining the loss upon ignition at 1,400 deg. F. of the pulverized dried neat cement. The combined water was taken to be the difference between the loss of the dried pulverized hydrated cement and the normal loss upon ignition of the dry fresh cement. The accompanying chart shows the hydration curves for both the specific gravity and ignition methods.

The rate of hydration is not likely to



HYDRATION CURVES for portland cements as determined from many samples by both the specific gravity and the ignition method.

be the same for any two different brands of portland cement, but of the brands tested the quantity of water consumed at any period above 28 days is very nearly the same.

In neat mortar of portland cement and water, stored 24 hours in moist air at 70 deg. F. and 68 days in water at 70 deg. F., approximately 1.32 gal. of water combine with one bag of cement.

In concrete with conditions of curing less ideal the rate of hydration would probably be slower; however, actual specific-gravity determinations of pulverized concrete cores, 60 to 90 days old, check very closely with the theoretical specific gravity of the concrete based upon the hydration rate of 1.32 gal. per bag of cement. (See accompanying table.)

While the water voids in the set concrete are decreased by virtue of the combination of water with cement, the yield is unaffected. The specific gravity of the cement is decreased in direct proportion to the volume of water consumed. Then the theoretical percentage of voids in set concrete is equal to the absolute volume percentage of water used minus the volume percentage combined with the cement.

Actual voids indicate yield losses

But actual tests for voids in concrete cores and cylinders reveal that the percentages are invariably lower than the theoretical by 0.03 to 5 per cent, depending upon the mix and the methods of handling and finishing the concrete.

If actual voids are lower than theoretical, it means, of course, that the concrete has been compacted to the point that water is forced out, either up or down, and the actual yield suffers to the extent that density is achieved. Concrete cylinders molded in the laboratory and carefully tamped until water first appeared upon the surface have actual voids much nearer the theoretical than do cores taken from pavements laid of the same mixture, which indicates that the yield of concrete may more closely approach 100 per cent if every care is taken to prevent losses of water.

With the current methods of placing concrete mixtures, with slumps above 1½ in., actual yields greater than 98 per cent are hardly possible. Most of us want to think that a 98 per cent yield is near enough to perfection, but not so with some contractors who rely much, perhaps too much, upon efficiency and who prepare bids accordingly.

Appreciation of the impossibility of obtaining perfect yields under ordinary methods of concrete pavement construction is reflected in the Georgia state highway department's 1933 standard specifications, which read in part as follows: "It is expected that the weighted average apparent cement factor will slightly exceed the theoretical cement factor but not by more than 2 per cent. If the contract price for concrete includes the cost of cement, adjustments for cost of cement will be made when the apparent cement factor varies more than 2 per cent from the theoretical cement factor."

The apparent cement factor is, of course, affected by the slab thickness, but discrepancies between theoretical and apparent cement factor cannot be explained by slab thickness as indicated by cores drilled from the pavement. In fact it is possible under the Georgia specification that a contractor may be paid for extra cement and penalized on the same job for deficient thickness.

Very dry mixtures, requiring vibratory methods of finishing, should produce the better yield; however, if vibratory methods are employed with wet mixtures, the yield loss will exceed the yield loss without vibration.

Cores drilled from a section of concrete pavement where subgrade felt was used show an average yield loss of 1.47 per cent, while cores drilled from sections where concrete of the same mix was placed directly upon the subgrade show an average yield loss of 2.93 per cent. The accompanying table shows yield losses sustained by different methods of handling various mixtures. The vibrated mixtures were obviously wetter than necessary.

YIELD LOSSES IN CONCRETE REPRESENTED AS DIFFERENCE BETWEEN THEORETICAL AND ACTUAL VOIDS

Proportions													Specific Gravities						Voids		Yield Loss
C. F.	Spec. Gravity Cement 3.20			Spec. Gravity Sand 2.64			Sp. Gr. Stone 2.68			Water			Theoretical			Actual			Theo.	Actual	
Bbl. Per Cu.Yd.	Wt. Lb.	Solid Vol. Cu.Ft.	P. C. Solid Vol.	Wt. Lb.	Solid Vol. Cu.Ft	P. C. Solid Vol.	Wt. Lb.	Solid Vol. Cu.Ft.	P. C. Solid Vol.	Wt. Lb.	Vol. Cu.Ft.	P. C. Vol.	Dry Mix	Total Mix	1.32 Gal. H_2O	Pulverized Con.	Dry Specimen	Wet Specimen	Calculation	Tests	
Cores From Non-Vibrated Concrete																					
1.45	94	.4708	10.11	178	1.081	23.22	378.5	2.275	48.86	51.7	.8289	17.80	2.727	2.42	2.65	2.66	2.38	2.44	14.01	10.33	3.45[1]
1.45	94	.4708	10.13	175.5	1.066	22.94	381.0	2.281	49.08	51.7	.8289	17.84	2.726	2.42	2.65	2.66	2.40	2.45	14.05	9.78	4.27[4]
1.45	94	.4708	10.12	180	1.094	23.50	376	2.260	48.56	51.7	.8289	17.82	2.726	2.42	2.65	2.65	2.29	2.40	14.02	13.59	0.43[3]
1.45	94	.4708	10.15	190.2	1.155	24.92	361.8	2.182	47.06	51.7	.8289	17.87	2.725	2.41	2.64	2.65	2.34	2.41	14.07	11.70	2.37[4]
Cores from Vibrated Concrete																					
1.45	94	.4708	10.12	185	1.124	24.15	381.5	2.289	49.20	47.90	.7687	16.52	2.725	2.44	2.65	2.67	2.36	2.44	12.73	11.77	0.96[2]
1.43	94	.4708	10.00	178	1.081	22.95	387.5	2.330	49.47	51.7	.8289	17.60	2.726	2.42	2.65	2.66	2.42	2.45	13.85	9.12	4.73[3]
1.42	94	.4708	9.90	178	1.081	22.73	395.2	2.376	49.95	51.7	.8289	17.43	2.726	2.42	2.65	2.65	2.39	2.45	13.72	9.81	3.91[4]
1.44	94	.4708	9.83	178	1.081	22.57	401.0	2.409	50.30	51.7	.8289	17.30	2.725	2.43	2.65	2.65	2.37	2.43	13.63	10.57	3.06[4]
Cylinders Made in Laboratory																					
1.45	94	.4708	10.11	178	1.081	23.22	378.5	2.275	48.86	51.7	.8289	17.80	2.727	2.42	2.65	2.68	2.33	2.42	14.91	13.06	0.95[5]
1.41	94	.4708	9.83	178	1.081	22.57	401	2.409	50.30	51.7	.8289	17.30	2.725	2.43	2.65	2.68	2.32	2.42	13.62	13.40	0.22[5]
1.33	94	.4708	9.26	178	1.081	21.27	450	2.704	53.18	51.7	.8289	16.30	2.721	2.44	2.65	2.66	2.32	2.43	12.83	12.80	0.03[5]

Legend: [1]Representing Average of 10 Cores. [2]Average of 5 Cores. [3]Average of 4 Cores. [4]Average of 2 Cores. [5]Average of 2 Cylinders.

Conclusions

1. Approximately 1.32 gal. of water per bag of cement is consumed in the hydration of portland cement, when cured under water at 70 deg. F. for 68 days.

2. The theoretical maximum percentage of voids in set concrete is equal to the total volume percentage of water used less the volume consumed in the hydration of the cement.

3. Actual voids in set concrete depend somewhat upon the mixture and the methods of handling and finishing; but where typical methods are employed, the actual voids in concrete will be from 1 to 4 per cent lower than the theoretical.

4. By the use of subgrade felt, nonabsorbent paper or other means to prevent absorption of the mixing water by the subgrade, the actual voids in set concrete can be made to approach the theoretical percentage.

Fresh-Water Reservoir Built for Aquarium

Recirculation system provided for fresh-water exhibits to conserve use of city water—Pipes and fittings of rubber, to avoid injury to fish through solution of metal

By R. Leedom
Project Engineer, New York Aquarium

THE CONSTRUCTION of a fresh-water reservoir for aquarium purposes, a project somewhat unusual in many respects, has been recently completed under the Emergency Relief Administration of New York City at the New York Aquarium, the historic old Castle Garden at the lower tip of Manhattan Island.

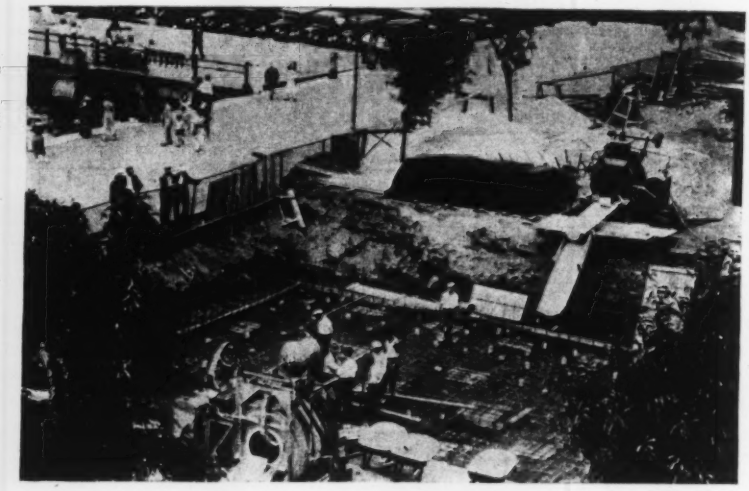


FIG. 1—RESERVOIR of 50,000-gal. capacity to provide water for New York Aquarium, shown while under construction.

The ancient Battery protection of New York, with its 10-ft. masonry walls and thick floors, was converted in the early nineties into an aquarium for showing aquatic life from all over the world. The exhibits are viewed annually by nearly two and one-half million people. In the early years of the present century, when the New York Zoological Society took over the management of the Aquarium, the water of New York harbor had become so polluted with sewage and refuse materials that it became unfit to support life for certain species of fish accustomed to the clear waters of mid-ocean, so that it was necessary to construct an underground storage reservoir of 100,000-gal. capacity for sea water. This water, with minor additions procured in tank ships from far at sea, has been filtered and purified and re-used over and over continuously for more than 25 years with great success. The exhibition tanks are as clear as crystal, and the life of the salt-water fish has been greatly prolonged.

The fresh-water fish exhibits comprise about half of the total at the Aquarium, and until four or five years ago the ordinary city water supply was used satisfactorily. However, about 75,000,000 gal., costing nearly $6,000, were consumed annually for this purpose, as no storage facilities were available.

Within the last few years the city water has become so cloudy and turbid that for about eight months of each year it has become practically impossible to view the fresh-water specimens. This cloudy suspension in the water has been of such a nature that it cannot be filtered out successfully, and chemical treatment of such enormous quantities of water has been out of the question at the Aquarium. To overcome this condition, to conserve the use of city water and to effect an actual saving to the society, it was decided to construct a 50,000-gal., reinforced-concrete, underground, fresh-water reservoir to store clear water during the summer months for re-use during the year.

The location of the reservoir, directly north of the Aquarium and adjacent to a seawall, in a park where public aquatic exhibitions and receptions attract enormous crowds occasionally presented requirements that are not ordinarily encountered in concrete reservoir construction. The water would be rendered completely unfit for its intended purpose if it were to be contaminated with salt or surface water or if it came into contact with any metals on its path of circulation between the reservoir and the exhibition tanks of the aquarium.

The following paragraphs describe very briefly the details of the construction decided upon and the methods of overcoming certain difficulties and ensuring an efficient and permanent installation.

The reservoir itself is about 43 ft. square, from 7 to 10 ft. deep inside, and is supported on 32 concrete piles. It is divided into four separate compartments by cross-walls, with an 8x8-ft. valve pit, 5 ft. deep, in the center of the structure. The entire structure is buried about 1 ft. below the lawn surface, and entry into the water and valve compartments is made through sealed manholes flush with the surface. To ensure absolute impermeability to outside water, it was decided to employ three precautionery waterproofing measures. The entire proposed structure was first surrounded with 4-in. non-reinforced concrete floor and walls. This concrete was mixed with a waterproofing admixture, poured in a plastic state and vibrated to make it waterproof in itself. On the inside of the 4-in. concrete shell were laid five plys of impregnated felt and fabric set up in six layers of special waterproof asphalt to prevent sea and groundwaters from entering the reservoir under the pressure heads due to the tidal ebb and flow through the porous subsoil. Inside of this doubly waterproof structure were placed the steel-reinforced main 12-in. floor, roof and walls. These were also poured and vibrated with a plastic concrete mix to ensure impermeable concrete.

The floor and roof were reinforced to withstand pressures of 850 and 450 lb. per sq.ft. respectively, while the walls also were amply reinforced to withstand the pressures due to submerging tides, which at certain periods reach a level 7 ft. above the reservoir floor.

The outside waterproof protecting slabs were poured during five-hour intervals of low tide, with enough time leeway to insure initial set before incoming tides might wash out the cement from the concrete mix and render it unable to withstand subsequent construction loads; and this structure was temporarily braced to withstand any stresses due to tidal loads incurred before the reinforced slabs were poured. All reinforcement spacing and wedging was done with precast concrete-block separators to prevent any metal coming into contact with the water that is to be stored.

The question of the buoyant effect of

the tides on the reservoir structure was investigated thoroughly. The only time at which this effect was even questionable was when the reservoir was entirely empty and the tide was extraordinarily high, a combination of circumstances unlikely to occur simultaneously. However, to cover even this condition, the reinforcement of the concrete piles was tied into the reinforcement of the bottom slab, making the tidal lift harmless, even with such a condition, before complete submergence occurred.

The reservoir proper is connected to the aquarium building by a 3x4-ft. reinforced-concrete pipe gallery, 100 ft. long, which passes under a roadway and is subject to the impact of passing 10-ton vehicle traffic. The gallery is waterproofed and reinforced with the same precautions employed as on the reservoir construction and may itself be utilized as an emergency storage reservoir of 9,000-gal. capacity. The pipe lines from the reservoir are carried in this gallery and through a tunnel in the 10-ft. masonry walls of the aquarium.

A 5x7-ft. concrete filter, 5 ft. deep, (see Fig. 3) was sunk in the masonry floor of the building at such an elevation that flow to it from the exhibition tanks, and away from it toward the reservoir, could be handled by gravity alone. The 140-ft. return drain from the exhibition tanks was made an open concrete structure for ease of collection and to aid aeration of the water. The return drain and filter were so designed and interconnected with removable dams and bypasses that the filter may be cut out entirely, or washed separately without interfering with circulation of fresh water to the specimens.

About 800 ft. of hard rubber pipe and fittings were used to handle the water. It has been found that the recirculation of either fresh or salt water year after year through metallic pipes dissolves enough of the metal in the case of iron or steel to render the water cloudy, and in the case of other metals to kill some of the more sensitive specimens. The hard rubber pipe was run, together with the open drain, along irregular courses in the polygonal structure of the old fort, and required great care in the placing operation.

In order to maintain the non-metallic nature of the circulating system, fiber rotary displacement pumps of 400-g.p.m. capacity were employed to raise the water from the reservoir to the first-stage filters on the second floor of the aquarium. These pumps are driven by 10-hp. variable-speed induction motors, and the rate of flow through the exhibition tanks may be closely controlled.

Along with the construction of the fresh-water installation, and under the same project, general repairs were made to the aquarium building itself. While a great many modifications and additions to the building have been made, the very nature of the subsoil and location of the old building permit slow and varying settlement of certain parts of the foundations and bulging of the walls. These settlements, together with natural decay, have necessitated certain repairs to the stucco covering of the building and to the roof rafters. The gutters, skylights, window frames and leaders were examined and replaced or repaired where found defective.

A maximum of nearly 150 relief workers has been employed in pushing the work to a conclusion. This group of workers has included engineers, supervisors, draftsmen, stenographers, timekeepers and representatives of numerous skilled trades together with their helpers and laborers.

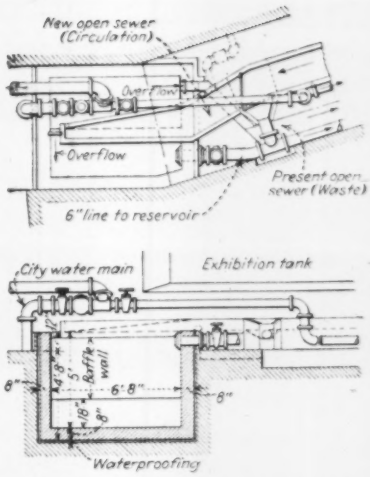


FIG. 3—WATER from the exhibit tanks is passed through this filter before it is returned to the reservoir.

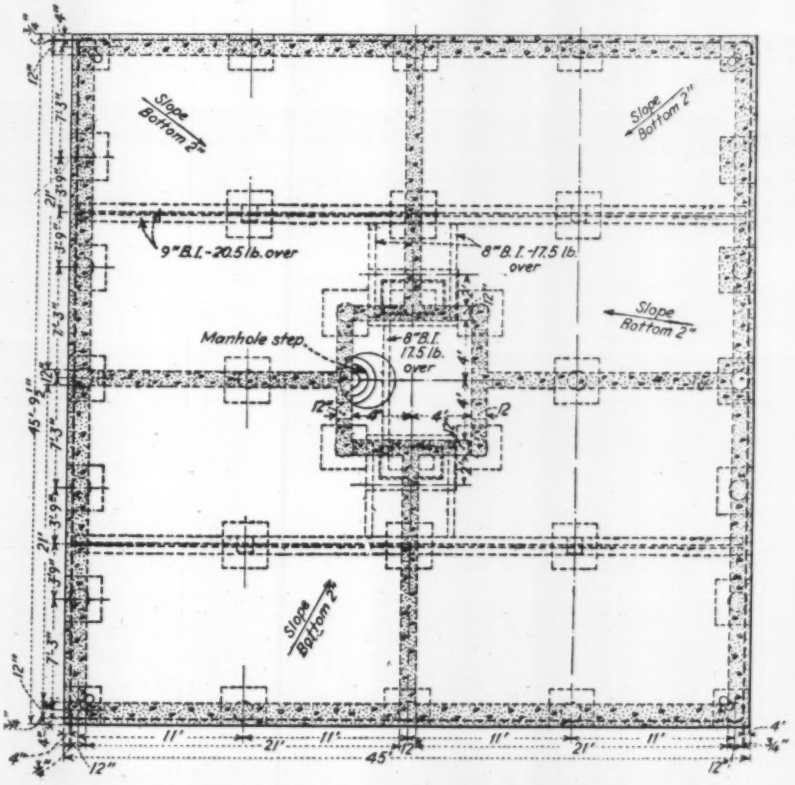


FIG. 2—RESERVOIR is divided by cross-walls into four compartments. The square compartment at the center is the valve pit.

Rules for Testing and Rating Combustion Engines Adopted

After months of study, standard rules for testing and rating internal-combustion engines for industrial applications have been adopted by the Internal Combustion Engine Institute. The standardizing of this procedure has been considered an important development in the field of industrial engines by engineers, governmental agencies and equipment manufacturers. The lack of uniform rating and testing methods, which resulted in a wide diversity of procedure, inconvenience and confusion to buyers, has now been corrected as the result of the intensive study by a committee of engineers appointed by the institute. The new regulations have been issued in printed form, and copies can be obtained from the secretary of the Internal Combustion Engine Institute, 111 West Monroe St., Chicago.

Roadbuilders Take Strong Action on Federal Highway Policies

Tax-diversion and force-account work condemned at Washington convention—Forty-hour week and eight-hour day urged, with right to employ any citizens of the state—Contractors demand separate highway code

INTEREST in current engineering and federal highway-financing problems called between 4,000 and 5,000 roadbuilders and manufacturers to Washington for the convention last week of the American Road Builders' Association. About 100 manufacturers had exhibition booths in the large ballrooms of the headquarters hotel, where literature, pictures, models and samples of their products were attractively shown.

A somewhat crowded program of papers strained the time of the convention despite simultaneous sessions of the county engineering, city engineering and construction divisions of the association. The papers were about equally divided between engineering traffic and administration problems. Discussion was limited and unexciting except at the sessions of the constructors where codes, force-account work and labor restrictions developed drastic criticism and action, which were reflected in resolutions latter passed by the association as a whole. In these resolutions the association took a positive stand on present and proposed federal highway administration policies as follows:

Resolutions

That we reaffirm our conviction that the best interests of the nation as a whole will be served by a discontinuance of diversion of highway revenue and a return to the sound practice of taxing highway users only to meet the reasonable needs of highway improvement and of restricting the expenditure of such revenues to meet the cost of highway improvement and maintenance.

That we recommend to the Congress and the President that a substantial part of the present public-works appropriation be definitely and specifically allocated for the improvement of highways, roads and arterial streets and for the elimination or reduction of grade-crossing hazards on existing highways, in order to provide more mileage of better highways, reduce the cost of motor transportation to the highway user and reduce the toll of accidental deaths and injuries now suffered in connection with highway transportation throughout the country.

That we recommend that the planning of highway projects and the disbursement of all such funds allocated from the public-works appropriation for highway improvement should be handled by the Bureau of Public Roads and the state highway departments, to make sure that they will be wisely allocated and efficiently expended in accordance with a consistent and established program for highway progress in each state.

That we recommened most earnestly that the expenditure of the funds allocated to highway improvement under the emergency construction act be carried on in accordance with the well-recognized and prevailing system of award to private contractors.

That we commend to the Congress and the President the CWA experience as a conclusive reason for not attempting to carry out an emergency construction program of ten times the magnitude by an improvised system of force account or day labor.

That in our judgment, an early announcement that highway construction under the emergency construction act is to be carried on by the contract system will result in the immediate purchase by equipment and material manufacturers of the raw materials and supplies required for use during the winter months in order to build up their inventories and stocks, thereby contributing to a greatly desired increase in employment in many industries. But any fear on the part of such manufacturers that this work is to be prosecuted by governmental day labor, using available rented equipment, will be a grave deterrent to such recovery of the manufacturing industry and will have an immediate tendency to increase present unemployment in those industries.

That in our judgment undue restrictions in the use of machinery, the renting of outworn or obsolete equipment or the destruction of the highway construction industry that would result from a general program of governmental construction by force account rather than by contract would go far toward canceling out the industrial gains made during 1934, and would substantially handicap further gains during the current year.

That we urgently recommend the discontinuance of all preferential exceptions, and that governmental buyers, contractors and other buyers be made subject to exactly the same conditions with respect to quoted prices and other competitive factors.

That we recommend that employment laws be amended to establish as the standard for federal highway construction projects a maximum working week of 40 hours, with a maximum of 8 hours per day for anyone, and that on all federal highway work the residence qualifications for employment shall be amended to provide that labor shall be drawn from residents of the state rather than of the county in which the work is located.

The highway field

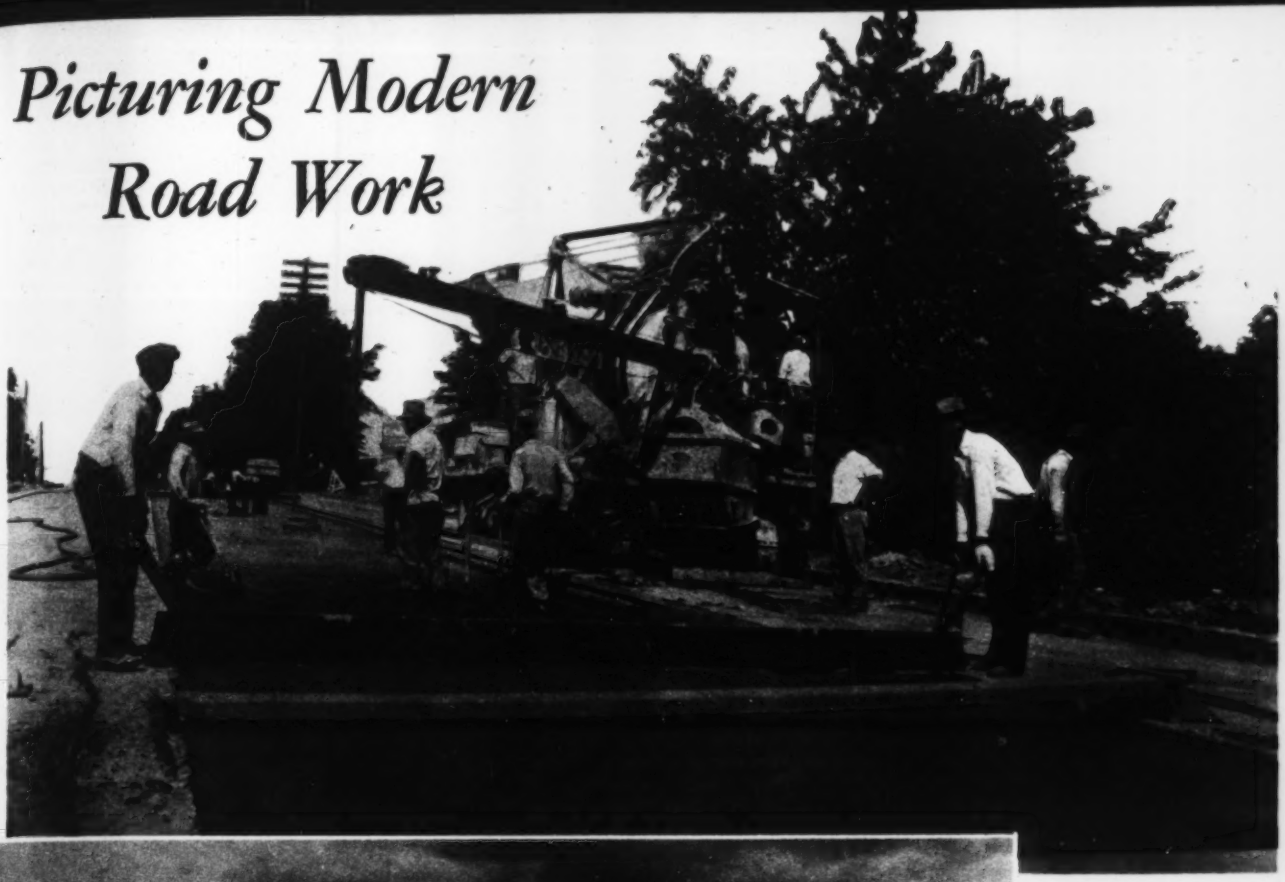
The importance and extent of the highway field still undeveloped was stressed in the opening address of the president of the association, Capt. H. C. Whitehurst, Washington, D. C. Condemning the notion that highways are overbuilt, President Whitehurst said:

> Of the 3,040,000 miles of rural highways in the United States only 920,000 miles have been improved, and of these but 160,000 miles have been improved with high-type surfacing. State highway departments have jurisdiction over 360,000 miles; counties and townships have jurisdiction over 2,680,000 miles. High-type surfacing has been placed on 120,000 miles of state highways, and about 170,000 miles have been improved with low-type surfacing, making a total of 290,000 miles improved out of the 360,000 total state mileage. There are, therefore, about 70,000 miles of main highways with no improvements whatsoever, as well as 170,000 miles, the greater percentage of which must be further improved and modernized. Of the total mileage of highways there are more than 2,000,000 miles which as yet have been unimproved. This high mileage of unimproved highways is being reduced by less than 2 per cent annually.

Modernization of existing improved roads was asserted to be equally as important as the improvement of additional mileages of unimproved roads. Commenting on current proposals for planning a national highway program by some super-authority, the speaker disputed any necessity of agencies other than the Bureau of Pubilc Roads and the state highway departments. In respect to highway work as an aid to employment, the statement was made that with one-third of the PWA funds it had supplied two-thirds of the total employment.

Discussing the expanding field of federal participation in highway development, Thos. H. MacDonald, Chief, Bureau of Public Roads, made the following remarks:

Picturing Modern Road Work



CONCRETING the base for a sheet asphalt four-lane road.

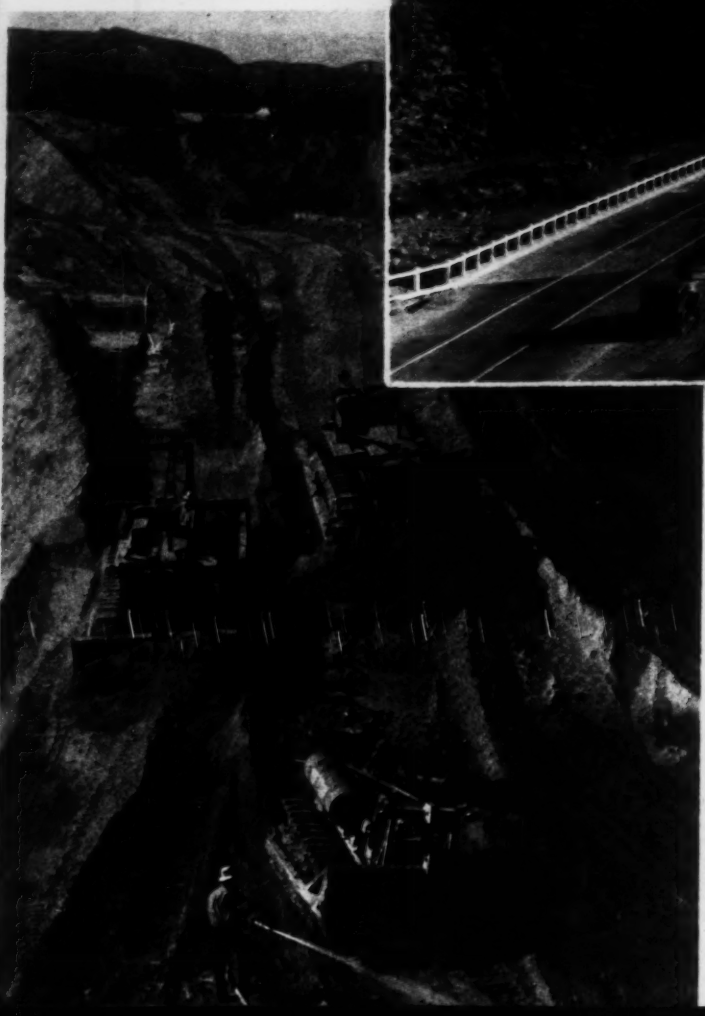
CONCRETE ROAD BRIDGE across the North Platte River on a Wyoming highway.

PRESSURE ASPHALT DISTRIBUTOR penetrating bituminous macadam.

BITUMINOUS SUR FACED ROADS *(left)* **lend themselves to har monious blending wit roadside.**

MODERN BRIDGES *(b low)* **make the full pa ment width continuou**

TRACTOR BULLDOZERS *(be low)* **pushing down a hill to level out the grade of California road.**



CONCRETING an arch bridge on the road leading to historic Concord.

GIVING EMPLOYMENT *(right)* by hand grading a secondary road in N. Y. State.

AN ARIZONA ROAD BRIDGE *(left)* with a flexible steel guard rail.

BLASTED LEDGES *(below)* are pushed flat by tractor bulldozers in modern road grading.

SERVICE PIPES are carried across modern road bridges and concealed by the deck slab.

TRACTORS and giant scrapers *(left)* grading approach road to a tunneling operation.

RIKEOFF MA-INES *(below)* in- exact depth of re- rcement in concrete pavement slabs.

CLOVERLEAF INTERSECTIONS eliminate left turns where modern roads cross.

Since July, 1933, in the public-works highway programs more than 11,000 individual projects have been placed under way. That 60 per cent of these projects are off the federal-aid highway systems of the states as they existed at the start of the program, roughly measures the velocity attained in broadening the program through liberalizing the federal highway policies. These projects off the federal-aid highway system provide for its extension at both its extremes—on the one hand the feeder roads of the rural districts, and on the other the principal thoroughfares of cities and towns. The addition of these two classes of roads and streets to the federally supported highway program is not the only element of this broadened highway policy structure. The elimination of grade-crossings without railroad participation in the financing, landscaping and planting of roadsides, and the building of footpaths, are other, but not all, of the worthy additions to the rapidly progressing highway policies.

Speaking of the trend in states to centralize road administration, Mr. MacDonald uttered the warning: "Of the benefits to be obtained by such transfers there is little doubt that they bring with them a danger if transfer of responsibility is not accompanied by commensurate provision for income."

Engineering progress

Discussion of engineering subjects of particular interest centered on pavement grade-crossings, stabilized soil surfacing and timber-bridge economics. Based on an analysis of 129 timber railway bridges for which complete cost records are available, J. F. Seiler, of the American Wood Preservers Association, gave and discussed vital statistics and economic calculation curves for creosoted timber bridges, from which he concluded that that there was marked justification for "the construction of intermediate types of bridge structures whose cost ratio, as between the highest and lowest, does not in general exceed 1.50 or 1.75 to 1.00, which may be taken as applying quite accurately to the concrete viaduct and creosoted-timber bridge types, respectively; that debt service charges alone, for any bridge structure costing 1.5 times as much as a creosoted-timber structure, will exceed the total carrying charges for the latter even over a period as long as 50 years."

Describing the familiar process of soil stabilization and the process of building up and maintaining surfaces of stabilized soil, H. A. Sours, county engineer, Summit County, Ohio, indicated new possibilities in commercial production of stabilized mixtures. He said:

> Plant mixing has been used to a limited extent in some parts of the country. Plants of the portable type as well as permanently located commercial plants have been utilized. Under certain conditions commercial plants which have a considerable amount of waste products might find an outlet for these waste materials by plant mixing.

In a comprehensive paper on the latest developments of hard-surface pavements, H. F. Clemmer, engineer of materials, District of Columbia, listed expansion joints, pavement base, non-skid bituminous surfaces, de-aired brick and removing filler from brick pavement, permanent traffic markers and subgrade stabilization.

Referring to recent development of air-cushion joints, Mr. Clemmer made the following statement:

> The highway department of the District of Columbia has used the air-cushion joints in all of its pavement work for over three years and believes this type of joint to offer particular advantages. Experience has shown that the space above the copper seal should not be poured or filled with a mastic material, as foreign matter such as gravel might be held in the joint space and cause spalling of the edges of the slab when expansion takes place. The open joint also eliminates the unsightliness of extruding filler. This department permits the use of the continuous-dowel type of air-cushion joint and has made experimental installations of these other types, and expects to give more definite consideration to those types of joints which provide for transfer of load across the joint without the use of dowel bars.
>
> Where dowels are used, a more efficient result would undoubtedly be obtained if the same cross-sectional area of metal were in the form of a T-bar rather than a round bar. A comparison of the features of the two shapes will show the main difference to be in the perimeter, bearing area and the moment of inertia. The increased bearing of the T-bar would permit a greater and more positive transfer of load. The moment of inertia for a T-bar is about six times that of a round bar of approximately equal cross-section, and as the stress in a beam is inversely proportional to the moment of inertia the T-bar would offer considerably greater strength. The practical use of this shape of bar has been demonstrated under field conditions.

In base construction the design, said Mr. Clemmer, should be as careful as that of concrete pavement. In recent work in the District of Columbia, he said, planes of weakness were placed not more than 15 ft. apart in all base slabs.

When construction was carried on during temperatures below 50 deg. F., expansion joints, in addition to the weakened planes, were placed at the tangent points of intersecting streets and at a maximum interval of 300 ft. The general practice of creating a plane of weakness was to make a groove in the concrete at least 4 in. deep by pressing a layer of building paper into the concrete by means of a metal strip approximately $\frac{1}{8}$ in. wide and extending the width of the slab. This groove was, of course, made prior to the initial set of the concrete. The metal strip was removed immediately after making the groove, while the layer of building paper was left in the concrete slab so as to prevent the adjacent sides of the groove from bonding. During the setting of the concrete a crack was formed for the remainder of the depth of the slab.

A survey of the asphalt surfaces placed on bases having planes of weakness each 15 ft. showed that but few major cracks (cracks open wide enough to permit of maintenance) have developed. It is believed that these planes of weakness served as expansion joints permitting free movement of the concrete and since they were placed close together (15 ft.) the movement of any one joint was so slight as not to cause a cracking of the bituminous surface. Where a crack did appear on the surface, it was straight and regular and not unsightly.

Contractors' problems

Widespread and vehement dissatisfaction with present working conditions governing roadbuilding by contract, under existing code and special federal and state regulations and restrictions, was expressed at three sessions of the highway contractors' division. Under the leadership of William P. McDonald, president-elect of the American Road Builders' Association and head of the Wm. P. McDonald Construction Co., Flushing, N. Y., the meetings culminated in the approval of a resolution to reorganize and vitalize the highway contractors' division into a militant body with an individual, legalized identity under the A.R.B.A. Its main purpose will be to fight solely and directly for the interests of the highway contractor who, it is contended, has occupied the rôle of stepchild in matters of code formulation and administration as well as those of legislation.

Pending congressional approval of the President's huge public-works program for unemployment relief, one of the first major activities to be undertaken by the new division will be the drafting of a code for highway contractors entirely separate and distinct from the existing basic general code (Chapter 1) for the construction industry and the supplementary divisional code (Chapter 2) for general contractors.

Present codes, the roadbuilders maintain, are dominated by the interests of the building contractor, with inadequate attention to the special needs of the highway contractor. Operating almost exclusively under federal or state contracts, rather than on private projects, and governed largely by federal and state regulations which take precedence over code mandates, the highway contractor, nevertheless, is paying his code assessments of one-

tenth of 1 per cent of the value of each of his contracts without, he asserts, getting much, if anything, in return for this outlay. To date, there has been no delivery of the proposed subdivisional code for highway contractors (Chapter 2 C, under the existing general contractors' divisional code) on which NRA officials and code sponsors have been laboring since last summer. This delay, the highway contractors contend, leaves them without any direct code sponsorship, the result being that in the administration of codes their interests are subordinated, in spite of the fact that they are contributing a large share of code revenue.

Labor restrictions attacked

But code complications are only part of the highway contractors' operating troubles. Coupled with them are the 30-hour week on all projects involving the use of federal funds, restrictions on the use of mechanical equipment in favor of hand labor on certain operations, and, topping all others in sinister influence from the contractor's point of view, mandatory selection of local personnel from employment relief agencies. Probably more and louder complaint was registered on the latter score than on any other during the meeting, with the single exception of the day-labor menace.

Job candidates from local employment lists, especially in the unskilled classifications, were found to be unfamiliar with or unadapted to highway construction, while so-called "skilled" machine operators from the same employment sources have caused contractors thousands of dollars' loss by damaging expensive equipment through clumsy and ignorant handling. As one delegate expressed it, the highway contractor, under present-day conditions, must literally conduct, at his own expense, a training school for prospective employees from relief lists, instead of being able to place upon the job an organization of experienced and skilled workers of his own choosing.

The rising tide of day labor instead of the contract method of performing work was characterized as jeopardizing the very life of the construction industry at this time. The newly organized highway contractors' division will undertake, as one of its primary objectives, to combat this growing menace which, particularly in the roadbuilding field, is threatening to wipe out the market for the contractor's services. In rallying the contractors' forces against the day-labor evil president-elect MacDonald said significantly, "We are fighting for our lives," a declaration strengthened by the fact that during the three contractors' sessions of the convention problems of construction technique that are ordinarily considered at length during these gatherings were relegated to the background and attention was focused almost exclusively on the problems of keeping the highway contracting industry from collapse.

So much for the general scope and tone of the highway contractors' sessions. On the general topic of construction codes E. Sutcliffe, president of the National Bituminous Paving Industrial Association, of Boston, referred to "chaotic conditions" traceable to code regulations inapplicable to highway contracting and to overlapping requirements of other codes, notably those dealing with crushed stone, trucking, and bituminous road materials, involving multiple code assessments. He recommended a separate, independent code for the highway industry.

C. E. L. Wagner, of Jefferson City, Mo., drew attention to the inconsistencies created by the fact that wages and hours prescribed by existing construction codes are superseded in highway work by wages and hours written into contracts by the state highway departments. The poor quality of labor which contractors are forced to obtain from local employment agencies has been responsible for a big increase in accidents.

F. A. Cannon, Milwaukee, told of the satisfactory working of local code administration in Wisconsin under that state's Recovery Act, passed in 1933. Under the state regulations a highway contractor is required to fill in and submit with his bid a standard estimate sheet providing for all items of cost, both direct and indirect. Standards of equipment ownership and rental have been established. Code enforcement is made effective by withholding the award of contracts.

W. L. Brown, of Lakeland, Fla., presented a paper by John E. Ballenger, describing the effects of codes on highway contracting in Florida. The highway contractor, it was stated, has gained no benefits from the codes; instead, he has experienced the disadvantages of cut-throat competition, damage to equipment, low production, loss of morale among construction personnel, and conflicting regulations governing rates of pay and hours of work for various but similar contracts.

Frederick Hoitt, secretary of the New England Road Builders' Association, offered recommendations for a "separate, distinct, complete and independent code for highway contractors, administered solely by highway contractors." To be effective, he said, a code must operate upon public officials as well as upon contractors. If the terms of the code entitle it to approval by the President, then the federal governmental authorities ought to be bound to conduct government work under code conditions. Because of the seasonal character of highway construction and the amount of time lost because of inclement weather, a 40-hour week was proposed, with provision for making up lost time. Mr. Hoitt endorsed the predetermination of minimum wage rates by public awarding officials. Code administration, he held, should recognize the principle of home rule, with full and complete powers vested in state code authorities.

Charles B. Cochran, of Marion, Ill., recited a number of unfortunate experiences with employment agencies in the provision of skilled and unskilled labor. By reason of local residence requirements skilled men of long experience often had to be dropped from a highway contractor's organization and replaced by incompetents. Mandatory selection of labor, Mr. Cochran pointed out, has increased highway-grading costs in Illinois 6 c. per cubic yard, has doubled equipment-operating costs and has made the preparation of reliable estimates of cost impossible. In Mr. Cochran's words, the highway job of today, is a "disintegrated madhouse," with accident frequency showing an alarming increase.

Some hope for relief from conditions that have lowered efficiency in building highways under present governmental regulations was offered in an address by R. E. Toms, chief, division of design, U. S. Bureau of Public Roads, who pointed out that the Bureau's representatives have no discretion in the enforcement of legislative requirements. Among possible future changes in governmental regulations he cited the principle of predetermined minimum wages, a revision of the 30-hour week to a 40-hour week, a recognition of the seasonal character of highway construction in determining hours of work and a greater latitude for contractors in selecting skilled labor of their own choosing.

Equipment developments

After remarks by Congressman J. B. Shannon, Missouri, on government competition with private industry, three papers on the latest improvements in roadbuilding equipment were presented. Bituminous-paving equipment was discussed by Bernard E. Gray, highway engineer of the Asphalt Institute; earthmoving equipment by Nello Teer, contractor, of Durham, N. C., and H. J. Spelman, principal highway engineer, U. S. Bureau of Public Roads; and concrete-paving equipment by E. M. Fleming, manager, highways and municipal bureau, Portland Cement Association.

These papers indicated developments of importance, particularly in substitution of diesel-engine power on heavy grading equipment, finishing machines for bituminous surfaces, vibratory finishers for concrete and dual-drum paving mixers. Speaking of grading equipment, the opinion was expressed that diesel-powered equipment seems to have a first cost 15 per cent over that powered with the internal-combustion engine. It is plausibly claimed, however, that this increased first cost will be more than made up by the greater promised life of the diesel equipment.

Reclamation Policy Held Sound in Committee Report

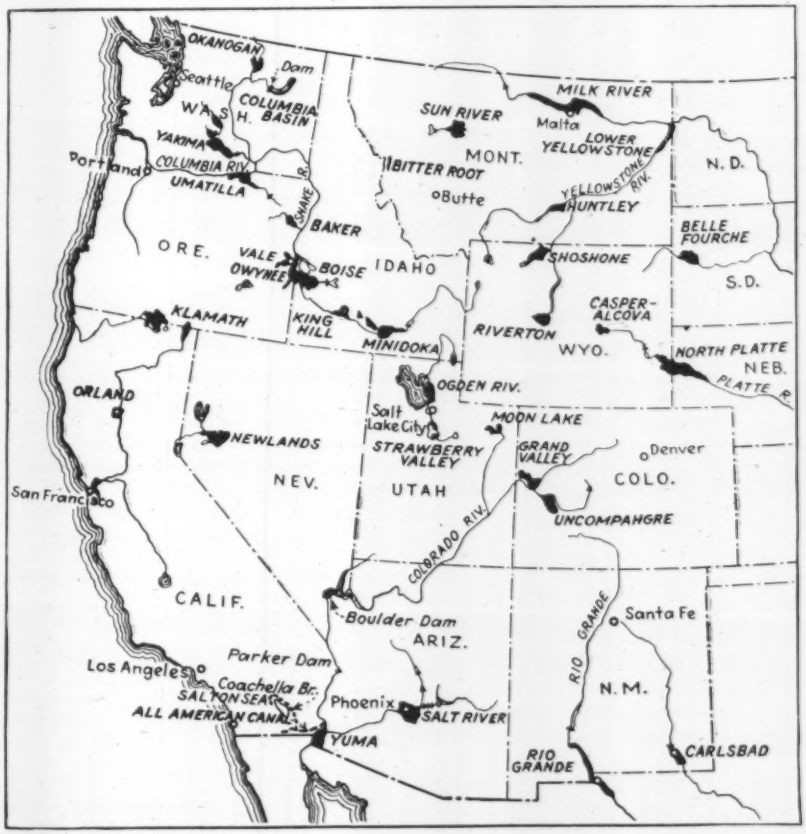
Recommends collection of repayments by bank system, planning based on stream-system development, federal control of storage, and adoption of a uniform power policy for the future program of irrigation in the arid West

APPROVAL of federal reclamation as "a sound and desirable undertaking" is coupled with recommendations for changes in repayment, selection of future projects on the basis of stream-basin planning, and a uniform policy on accompanying power development in the report of a special committee appointed some months ago by Secretary of the Interior Harold L. Ickes to study present reclamation and suggest needed modifications. The committee consisted of John W. Haw, director of agricultural development, Northern Pacific Railway, and F. E. Schmitt, editor, *Engineering News-Record*. Its report was made public last week.

Considering "not alone the quantitative facts of irrigation development, but also the far-reaching social and economic changes which it produced, the committee found that reclamation "contributed toward integrating the nation" and that it "has been a fundamental agency of national public welfare." By implication rather than direct statement, the committee holds that reclamation has an appearance of financial insolvency, and lays the blame for this condition largely on the law that made the Bureau of Reclamation the fiscal collection agency, together with the attitude of some irrigators that they are "wards of the government." Recommendations are made to correct these essential difficulties.

In its review of reclamation history the committee noted that the national program was instituted with the passage of the Reclamation Act of 1902, which provided a revolving fund to be kept intact by repayments of construction costs during a term of years by the owners of land in the projects, free of interest. "The original term was ten years, but it has since been extended to forty years, and in a few instances will be longer, as some of the annual payments are fixed at 5 per cent of the gross crop value. Under this system about one-fourth of the expenditure, or $53,754,276, had been returned to the government up to June 30, 1934. Present annual installments of return to the government, including both the water-users' payments and various non-farming revenues (chiefly power-plant operation and grazing-land leases) would amount to about $3,000,000, or 1½ per cent of the total reclamation expenditure. Because of the moratorium acts passed by Congress to apply to the years 1931 to 1934, only a small amount of this money has been received since 1930."

FIG. 1—PROJECTS of the Bureau of Reclamation and their location in the states of the arid West. The bureau has completed 31 projects, embracing 2,025,500 acres.



EXPENDITURES AND REPAYMENT FEDERAL RECLAMATION PROJECTS

Expenditures	
Primary construction cost	$203,991,096
Purchase of constructed works	2,066,940
Supplemental construction	12,627,449
Operations during construction	2,804,745
Operation deficit added	6,956,939
Total	$228,437,169
Charge off (Act of May 25, 1926)	$15,615,332
Repayable costs	$212,821,837
Repayment	
Payment by water users	$43,039,204
Contributed funds	2,783,013
Power revenues	6,590,770
Other credits	3,141,289
Total	$55,754,276
Balance to be repaid	$157,067,561

Findings of report

The seven definite findings made in the report and the essence of the supporting material follow:

1. Reclamation by irrigation of land in the arid and semi-arid western part of the United States is shown by its results to be a sound and desirable national undertaking. It represents a constructive policy of social development.

2. Reclamation should be continued by the federal government as available means may permit.

Reclamation is held to be an important agency in the redistribution and re-settlement of population, which has been emphasized by the accelerated migration from the marginal areas of the Great Plains during the past season of drought. "It is important that existing irrigated areas be stabilized and rehabilitated, and additional irrigated areas developed as may be economically feasible. Since private and district enterprise no longer serve this purpose, federally aided reclamation should be continued as the only means available."

Countering the frequently quoted statement that products from reclamation projects contribute materially to the national surplus of agricultural

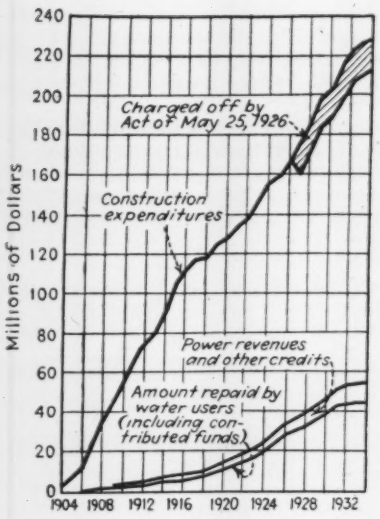


FIG. 2—CONSTRUCTION expenditures for federal reclamation projects totaled $228,437,169 (before charge-off) compared to repayments by water users of $42,239,204.

crops, the committee states that "Reclamation agriculture has little relation to the problems of surplus agricultural production. The crops produced on the projects are in the main not those staples that are overproduced. A large part of the project crops is consumed in the West itself, and the staples produced on the projects have been absorbed by the increasing consumptive requirements of the West directly attributable to irrigation development." [See Fig. 3.]

3. Except for the influence of the present depressed farming conditions, the operating projects are in the main excellently developed and represent strong, properous communities.

The committee contends that agriculture on federal reclamation projects has no reason for claiming "preferential treatment over other agriculture, and it should be held subject to the same requirements of solvent and self-reliant action and payment of debt obligations as apply to all farmers." Further, the report emphasizes that the pleas of inefficient farmers and the occasional farm failures on projects are not to be interpreted as failure of the projects themselves.

It is held that because of improving farm income, most of the projects should be able to resume payment of construction costs next year. Pointing out possible exceptions where projects suffered from water shortage during 1934, the committee "believes that no general moratorium should be granted."

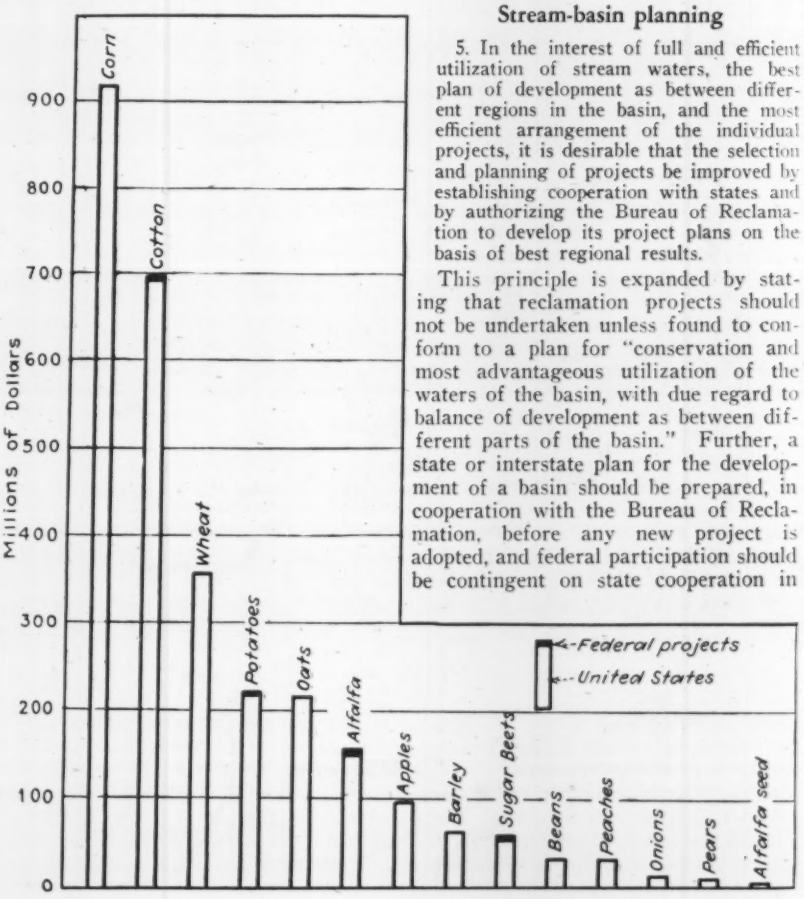
Financial problems

4. Present reclamation procedure encounters its most troublesome problems in the financial relations between the water user and the government. These problems arise from the fact that the Reclamation Bureau, though not a banking agency, is required to carry on the banking function of collecting the installment payments on the cost of the work. The Bureau of Reclamation should be relieved of the responsibility for collection in the case of all future projects. If practicable, the revised collection system should be applied also to the operating projects.

As a corollary to this finding, the report recommends that the bureau cease the operation of a new project not later than one year following initiation of water supply.

Corrective legislation suggested by the committee would: (*a*) relieve the Bureau of Reclamation from collecting construction charges; (*b*) transfer the collection responsibility to a banking organization against first-lien mortgages on the property; (*c*) fix the sale price or water user's payment for the irrigation improvement at not greater than the fair value of the irrigated raw land; and (*d*) establish a fixed rule for the amount of federal aid to be contributed to a proposed reclamation project as allowance for the national benefit.

FIG. 3—THE FALLACY of attributing agricultural overproduction to federal reclamation is indicated by this graphic comparison of the value of crops from the projects to the total for the country.



This suggested program for modified financial arrangements would apply to future projects, but the committee believes that the revised collection method should be applied also to existing projects where practicable.

On the subject of government contribution to the cost of a reclamation enterprise and the indirect benefits, as compared to the cost which the irrigator should bear directly, the committee points out that while the Reclamation Act nominally provides for collecting the full cost of the improvement from the settler, the no-interest feature and the long terms of payment (40 to 60 years) cause the government to pay from one-third to one-half the cost. In this connection the reclamation report makes the following pertinent statement:

"The public contribution to reclamation costs, sometimes called a subsidy, is actually a payment for the distributed benefits to others than the project farmers—to adjacent communities and industries, to the state in which the project is located, and to the nation as a whole. It is obviously necessary that these distributed benefits should continue to be paid for by others than the farmer. *The farmer should be required to pay only for the value of his irrigated land*, represented by capitalization on its average earning power and capable of ready appraisal."

Stream-basin planning

5. In the interest of full and efficient utilization of stream waters, the best plan of development as between different regions in the basin, and the most efficient arrangement of the individual projects, it is desirable that the selection and planning of projects be improved by establishing cooperation with states and by authorizing the Bureau of Reclamation to develop its project plans on the basis of best regional results.

This principle is expanded by stating that reclamation projects should not be undertaken unless found to conform to a plan for "conservation and most advantageous utilization of the waters of the basin, with due regard to balance of development as between different parts of the basin." Further, a state or interstate plan for the development of a basin should be prepared, in cooperation with the Bureau of Reclamation, before any new project is adopted, and federal participation should be contingent on state cooperation in

planning, water control, land use and industrial development.

The problem presented by water-rights litigation and conflicting water laws is recognized by the committee in any such planning program with the comment that "It is desirable that full adjustment of water rights in the basin concerned be required before a project is undertaken, and that the water control board or boards concerned appropriate or withdraw for use in the public interest all remaining waters."

The present system of soil study and classification of land on proposed projects should be continued, in the opinion of the committee, and the bureau should determine the value of a proposed improvement for the purpose of fixing different sale prices for different classes of land on the project.

Settler selection is found to be operating excellently, and there is the additional suggestion that for avoiding delay in settlement resulting from the hardship of pioneering new land, the bureau might be authorized to carry on some predevelopment work on projects, as by leveling and seeding a 10-acre tract on each farm. Agricultural aid and supervision of projects after completion should be sponsored by the state. Guidance in agricultural methods can be best placed in the hands of the state agricultural colleges.

Control of water

6. For permanent security of irrigated agriculture, future reclamation should, if practicable, include measures that will prevent overdevelopment of land beyond the water supply allocated to the project. Control of storage should remain in the hands of the federal government to insure equitable distribution.

With the approach of full stream utilization on many of the rivers in the West, the danger of overexpansion of irrigated areas is particularly serious because the limit of available water, including storage, has been reached. "Under these conditions it is highly desirable that means be devised to assure that overdevelopment cannot occur."

Power policy

7. A uniform policy to govern power development or to be developed in connection with reclamation projects should be established by law.

The committee states that, "It seems clear that reclamation power policy should not disagree with any broad power policy that may be found desirable in the general interest." Among the conclusions reached by the committee on the question of policy for power development on reclamation projects are: (1) In existing plants the responsibility and risk should rest on the water users. (2) New plants should be planned on the principle that power production and farming are independent businesses. (3) Costs should be fully computed and charged directly against the respective services, joint facilities being fairly allocated. (4) It should be affirmed as a fundamental principle that power residing in falling irrigation water should not be granted to the irrigator in perpetuity but should remain the property of the public. (5) Revenues from future plants should revert to reclamation funds.

Water Resources Inventory Presented by Federal Body

Water planning committee, in its report to National Resources Board, presents coordinated basic data for nation on water resources, the uses that are now made of them and the abuses to which they are subject—Advisory planning agency recommended

IMMEDIATE development of plans for the utilization of certain of the nation's water resources is recommended by the water planning committee in its report recently submitted to the National Resources Board, made public on Jan. 18. The committee urges federal participation with the states in carrying out a unified policy in regard to water resources and the creation of an organization for advisory planning for the use and control of water resources. An exhaustive inventory of the waters of the nation, their use, abuse and potential value, was prepared under the direction of the committee and served as a basis for its recommendations.

The water planning committee's report is the fourth and final one of the four sections previously summarized in the general report of the National Resources Board. The other three sections have dealt with land, minerals and mapping.

The water planning committee consists of Harlan H. Barrows, Herbert F. Crocker, Glen E. Edgerton, Henry F. Graves, Edward M. Markham, Charles H. Paul, Harlow F. Person, Sherman M. Woodward and Morris L. Cooke.

Early in its existence the committee undertook to collect data pertaining to the nation's water resources and the extent to which they have been developed and utilized. The first step in this work was the preparation of reports by eight regional water consultants and their staffs covering the major drainage regions of the United States. The second step was to abstract those reports and to prepare from them an inventory of water resources and the uses that are made of them. This work was organized and directed by Thorndike Saville, professor of hydraulic and sanitary engineering, New York University, who acted as executive engineer for the water planning committee. The regional water consultants were H. K. Barrows, H. P. Corey, Brent F. Drane, O. N. Floyd, W. L. Huber, Joseph Jacobs, Charles H. Paul and L. K. Sherman. In addition, the following specialists were also consulted: W. S. Cullings, Willard E. Herring, Robert E. Horton, Sheppard T. Powell, Howard E. Simpson, and Abel Wolman.

The following paragraphs present an abstract of the inventory study prepared by the committee.

Precipitation

Most of continental United States is within the zone of prevailing westerly winds. This accounts for relatively high precipitation on the windward side of the principal mountain barriers. The great interior basins comprising the Colorado, Rio Grande and Mississippi systems are affected, especially during the summer months, because the interior land area comprising them is remote from large bodies of water. Moisture brought from the Pacific Ocean by the westerlies is precipitated as these winds rise over the coast ranges and the Rocky Mountains on their way eastward. Because of these mountain barriers, therefore, little or no moisture from the Pacific ever reaches the Great Plains. The Appalachians, being much lower, have less effect in preventing moisture-laden easterly winds from entering the interior.

Between the Sierra Nevada-Cascade Mountains and the Rocky Mountains is a vast semi-arid and arid region. Moisture-bearing winds from the west and from the east are blocked by mountains; the south opens on the desert of northern Mexico. Local convectional storms, the westerlies, and occasional winds from the Gulf of Mexico bring a little rain to this area, but agriculture is possible only where water from the mountains is available for irrigation.

Accompanying the report is a map showing the average annual precipitation over the United States. It is based upon more comprehensive data, especially for the West, than were avail-

able for the map published in 1922 by the United States Weather Bureau.

A study of annual precipitation by means of moving averages shows that there are always successive periods of high and low precipitation. These periods do not have any constant time interval between them, and they do not synchronize in different parts of the country or even in near-by regions. Every unbiased study made by the Weather Bureau and other qualified observers indicates that low periods of precipitation will be succeeded by periods of high precipitation, and there is every reason to believe that within the next few years precipitation will tend to increase over the regions affected by the recent drought.

Substantiation of this forecast is to be found from long-term records of precipitation, which show that periods of low precipitation even greater than those now being experienced have occurred, always to be succeeded by periods of high precipitation.

Evaporation—Water losses by evaporation range from a minimum of about 20 in. in the cool damp northeastern and northwestern parts of the country to a maximum of more than 80 in. in the hot dry Imperial Valley of California.

Surface waters

The proportion of rainfall appearing as runoff varies from a maximum of more than 75 per cent on areas supplied from the snow fields of the Cascades to less than 10 per cent over large areas of the Great Lakes and the Intermontane area. It increases to between 30 and 50 per cent over the west slopes of the Rockies, and then decreases rapidly to from 30 to 3 per cent over the Great Plains.

Still moving eastward, the proportion of rainfall appearing as runoff increases, until in portions of the Tennessee Basin it reaches as much as 55 to 65 per cent. On the east side of the Appalachians there is a fairly uniform relation ranging from 40 to 50 per cent in the North Atlantic drainage and 35 to 45 per cent in the South Atlantic drainage.

Areas draining the Cascade and Sierra Nevada Mountains have a high yield, particularly toward the north, where yields as high as 75 in. annually are common, and a maximum average runoff of 175 in. is estimated for small areas. Between these mountains and the coast ranges there are lowland areas, long and relatively narrow, of low yield. Throughout the vast area between the Cascades and Sierra Nevadas on the west and the Continental Divide on the east, the yield also is very low.

Passing eastward from the Continental Divide to about the longitude of central Kansas, a progressive decrease in annual runoff is observed, with a minimum of less than 1 in. over considerable areas. From central Kansas eastward there is a fairly uniform increase that culminates in the Appalachian range, in the southern portions of which the runoff is in excess of 45 in. in places. From the eastward slopes of the Appalachians to the Atlantic Coast the annual runoff decreases more or less progressively to yield between 20 and 10 in. in the northeastern and southeastern parts of the country, respectively.

In the areas bordering the Great Lakes and the Gulf of Mexico, the rather uniform longitudinal changes in annual runoff are lacking. Due to the influences of these bodies of water in causing increased rainfall near by, a corresponding slight increase of runoff occurs, as compared with that from adjacent areas farther inland.

There are nearly 3,000 active gaging stations for the collection of runoff data, most of which are operated by the United States Geological Survey. The regional water consultants and hydraulic engineers generally are unanimous in

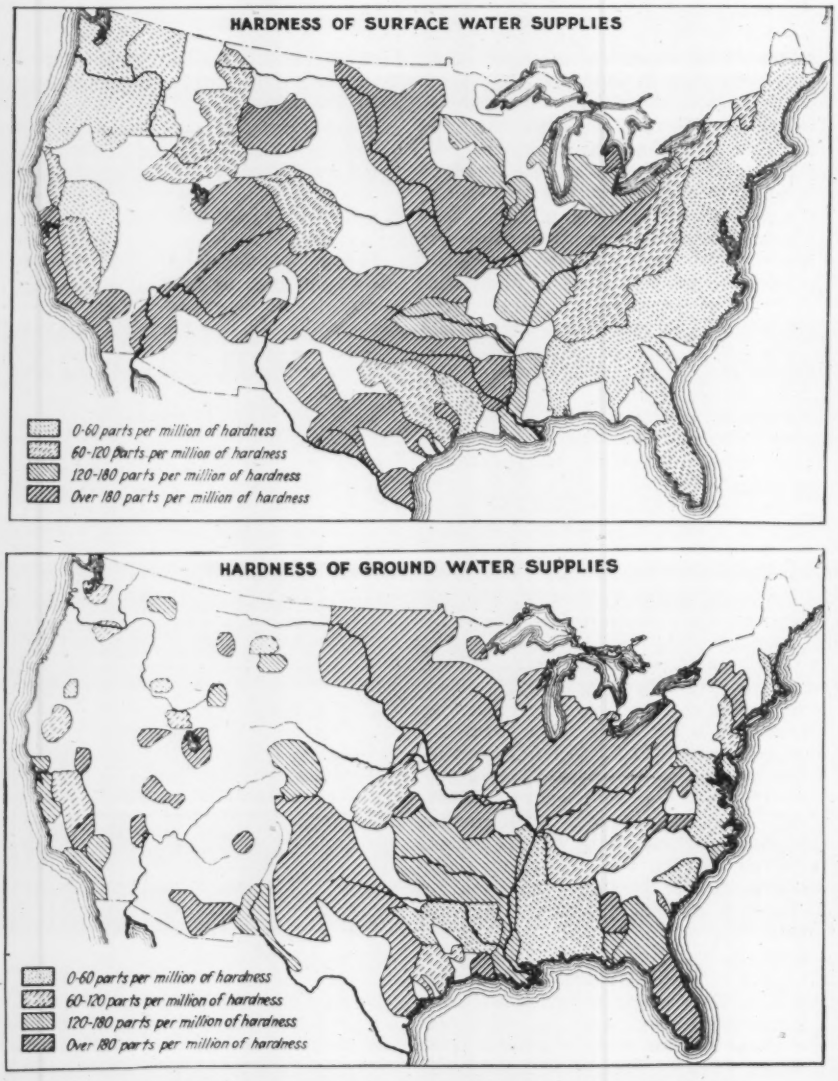

HARDNESS OF SURFACE WATER SUPPLIES
0-60 parts per million of hardness
60-120 parts per million of hardness
120-180 parts per million of hardness
Over 180 parts per million of hardness
HARDNESS OF GROUND WATER SUPPLIES
0-60 parts per million of hardness
60-120 parts per million of hardness
120-180 parts per million of hardness
Over 180 parts per million of hardness

FIG. 1—HARDNESS of the surface and groundwaters of the United States. The blank areas represent those areas in which data are not available.

NUMBER OF STREAM-GAGING STATIONS IN ACTIVE OPERATION BY FEDERAL AGENCIES, SEPTEMBER, 1933

Region	Number of Stations		Area	No. of Stations per Square Miles
	Geological Survey	Corps of Engineers		
1. North Pac.	584	.....	270,000	2.16
2. South Pac. and Great Basin	431	.....	300,000	1.44
3. Colorado	122	.....	245,000	.5
4. Western Gulf	150	.....	310,000	.48
5. Southwest Miss.	89	.....	280,000	.316
6. Missouri	311	.....	520,000	.6
7. Upper Miss.	154	2	190,000	.82
8. Alluvial Miss.	31	17	47,000	1.02
9. Ohio	333	.....	204,000	1.63
10. Red River and Great Lakes	187	.....	240,000	.78
11. North Atlantic	309	.....	130,000	2.37
12. Eastern Gulf and South Atlantic	245	.....	290,000	.842
Total	2,954	19	3,026,000	.98

the statement, however, that the provision of basic information on streamflow necessary to plan for the highest and most effective uses of both water and land requires the establishment of at least 10 per cent more stations.

Groundwater

Over much of the country, groundwater is a resource even more important than surface water. The amount of groundwater in general is great where rainfall is great, though water entering the ground in one place may flow underground to another. The United States may be divided into two groundwater zones corresponding to the humid and arid zones. These may be separated by the line of 20 in. of annual rainfall, which follows approximately the 100th meridian and divides the country into two nearly equal parts.

The quality of groundwater varies in general with the quantity. Where abundant, it is commonly potable; where sparse, highly mineralized. Shallow mantel-rock waters are usually of better quality than deeper bedrock waters, having had less contact with mineral matter beneath the surface. Most deep artesian waters are highly mineralized. Shallow waters are more commonly polluted, however, from surface contamination and organic matter.

Further factual surveys and investigations of groundwater resources are indispensable for their proper administration, equitable allocation and more efficient utilization.

Water quality

Hardness — The North and South Atlantic and North Pacific drainage basins are favored with soft surface waters. In the North Atlantic region, where this condition obtains and where the supply available is also generous and widely distributed, we find the highest concentration of industries. The groundwater over most of these areas is also of a hardness below 120 p.p.m., with the notable exception of Long Island, a portion of New York and New Jersey and parts of the Appalachian region and the Florida peninsula.

The surface waters of the Ohio Valley and Great Lakes drainage basin are moderately to excessively hard, increasing toward the north, while the groundwaters generally have a hardness above 180 p.p.m.

Both the surface and ground supplies of the Missouri and the northern and southern Mississippi basins range from 60 to 120 parts of hardness in the south to extremely hard water in the north. Sources of soft water, which characterize the South Atlantic basin, appear occasionally in the southern Mississippi and the western Gulf of Mexico regions.

Underground water accounts for more than half of the supply of the states surrounding the Gulf of Mexico. A region of scarce and very hard water extends from the Mojave Desert to the Colorado Basin into the western Rio Grande Valley.

The surface waters of the Pacific Coast are reasonably soft in the upper valleys, with increasing hardness toward the coast. Underground supplies of considerable hardness serve about 70 per cent of the population in this region.

Mine Drainage—A number of plans for correction of mine-drainage wastes have been advanced, and some improvement has resulted from cooperation between the mine operators and the states where mine drainage is serious. The magnitude of this problem is illustrated by the fact that the cost of neutralizing the acid discharge into the streams of Pennsylvania would be $75,000,000 annually for the capital investment, and from $41,000,000 up annually for operation of neutralizing plants. It is recognized that neutralization of acid waste is not a practical solution of the problem, and it is probable that sealing of the vents at the mines is the least expensive and the most satisfactory control method. The expenditure of $200,000, advanced as a CWA project in Pennsylvania during the winter of 1933-34, resulted in sealing 286 mines, closing 13,000 drifts, shafts and caves, and sealing 768,000 lin.-ft. of crevice. This work was done on the watersheds of the Allegheny, Monongahela and the west branch of the Susquehanna River. While it is not possible to determine at present the value of this work, it is indicated that there has been a satisfactory reduction in the acidity of the streams affected.

Recommendations—It is recommended that study be made by the federal government along the following lines: coordination of the results of the agencies now engaged in the chemical analyses of water; study of the influence of stream control and irrigation projects on the quality of water and a correlation of the data on the potential savings of such control; a study of the incursion of salt water into tidal streams as a part of flood-control measures; and a study of the advisability of federal control of interstate waterways with special reference to domestic, industrial and mine-drainage pollution.

Public water supplies

A study of the statistics of water quantity and quality, population growth and depreciation of water quality by domestic and industrial waste indicates clearly the existing and predicted local and national public water-supply requirements. There are three outstanding conclusions, which are: (*a*) existing and increasing pollution loads on surface waters cannot be continued without irreparable damage to water quality; (*b*) the rapidly increasing consumption of water in areas of concentrated population must be regulated by conservation, through the elimination of extravagant use and other avoidable wastes; (*c*) conservation of waters now going to waste should be more generally practiced through control by reservoirs and other measures to regulate streamflow.

Water-Supply Sources — Three-fourths of the population served by public water systems use supplies obtained from surface waters. Although an ample water supply is necessary for every community, a lack of readily available sources has not been a limiting factor in the development of our cities, except in desert areas. Water of satisfactory quality can be obtained almost everywhere by proper treatment of near-by sources or by impounding the runoff of distant watersheds. However, a demand for an adequate supply has made it necessary for several large cities to bring water from great distances.

In many parts of the United States it is possible to obtain from underground sources water that is clear, pure and palatable, although often hard and highly mineralized. About a third of the people of the United States live in 90 cities of more than 100,000 population, another third in smaller towns and villages, and the remainder on farms. The latter two-thirds depend extensively on groundwater.

The use of groundwater is reflected in the analysis of statistics of water systems supplying 67,000,000 persons. A fourth of this total uses groundwater, but more than half of these are in the populous area east of the Mississippi and north of the Ohio, where surface supplies are also abundant. Groundwater serves four-fifths of the consumers in Florida, and one-half to two-thirds of the other states around the Gulf of Mexico. These sources are still more important in the dry Southwest.

Two and a half million consumers in eighteen of the larger cities use groundwater. The available volume of underground supplies in certain sections is limited, and excessive pumping has caused contamination by infiltration of sewage or salt water. This has occurred in Florida, on Long Island and elsewhere in coastal regions.

Water Purification—Over half of the public water-supply systems of the country deliver untreated water to their consumers, who represent about one-fourth of the population served by public water supplies. A still larger number of persons use water that has been treated only with chlorine. The remaining 35,000,000 use water that has been subjected to some form of filtration, usually followed by chlorination.

Consumption—There are about 7,100 public water-supply systems in the United States serving 80,000,000 people. Over 1,000,000 cu.ft. of water is used by this group every day. The weighted-average water consumption of 37,000,000 users, living in 90 cities of

more than 100,000 population, was 127 gal. per day in 1928.

Waste disposal

Sewage — Pollution of streams by domestic sewage has become very extensive in the past few decades. Today many of the major cities discharge their untreated or partly treated sewage into adjacent bodies of water which have already exceeded or are approaching their diluting capacity.

In general, most communities require at least partial treatment of their domestic wastes. In some cases plain subsidence for the removal of settlable solids is sufficient, while elsewhere elaborate chemical and biological processes are necessary.

The total investment required to give partial treatment for the 1930 population which now has sewers but no treatment is estimated to be $140,000,000, which is about equal to the amount of capital invested in existing disposal plants; the amount conservatively calculated to give complete treatment to all communities is $380,000,000. These indicated capital requirements are in addition to PWA grants of $30,000,000 for these facilities.

Industrial Wastes—In almost every industry the processing of raw material separates part of it as waste. Frequently there are also spent processing materials. In its preoccupation with finished products, industrial management has often neglected reclamation research and has even abandoned marketable wastes. For many liquid industrial wastes, the only available disposal is a body of surface water or a public sewer. Byproducts frequently impose a heavy added burden on sewage-treatment works and may seriously interfere with normal operation of such utilities.

There are obvious centers of gross pollution that require remedial measures immediately. The discharge of excessive quantities of industrial wastes and of mine drainage in many industrial centers is resulting in rapid depreciation of surface waters, destroying the value of these resources for domestic, industrial and recreational use.

Interstate problems are acute in water-pollution control as in other elements of water conservation. More effective action is justified by regulatory bodies to encourage reduction of industrial waste pollution by economic recovery measures and to require more adequate and widespread treatment of domestic sewage.

Irrigation

Irrigation is practiced to greater or less extent in virtually all parts of the country. In the eastern, central and southern states irrigation is practically limited to flowers and lawns, garden truck, fruit and the like. Generally domestic water supplies are used, although supplemental irrigation from other sources is increasing rapidly.

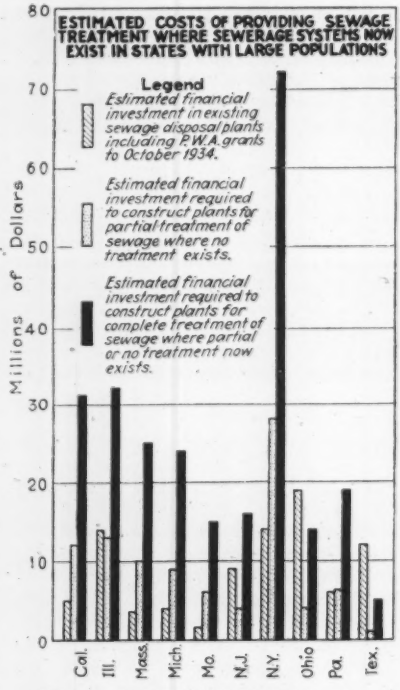


FIG. 2—SEWAGE-TREATMENT plant investment required in the several large-population states.

West of the Mississippi, and particularly west of the lower Missouri, the inevitable hazard of periods of low rainfall is taken more or less into consideration in the selection of unirrigated crops. The cost of irrigation for general farming is not warranted in most districts, and the supply of water available for the purpose is restricted.

Before the eastern foothills of the Continental Divide are reached, there are scattered irrigation systems for field crops and, to an increasing extent, commercial truck gardens; farm-home gardens are watered artificially.

In the truly arid regions farther west, irrigation generally is the price of agricultural settlements, and full land use in impossible without it. The various irrigation enterprises have made possible the growth of entire civilizations and constitute their chief support.

In general, there are very few entirely undeveloped irrigation opportunities. Few irrigated areas have attained their maximum possible development, however, though most of them have been expanded well beyond their present water-supply provisions.

The lands now irrigated and ultimately irrigable in the arid and semi-arid states are estimated as shown in the accompanying table, in percentages of the total land areas of those states.

LANDS IRRIGATED AND IRRIGABLE

States	Total Area of State (Square Miles)	Per Cent of Total Area Now Irrigated	Per Cent of Total Area Probably Ultimately Irrigated
Arizona	113,956	0.8	4.8
California	158,297	4.8	16.9
Colorado	103,948	5.1	7.55
Idaho	83,888	4.1	6.74
Kansas	82,158	.1	2.58
Montana	146,997	1.7	3.97
Nebraska	77,520	1.1	3.31
Nevada	110,690	.7	1.37
New Mex	122,634	.7	1.72
North Dak	70,837	.02	.82
Oklahoma	70,057	.004	.22
Oregon	96,699	1.47	4.94
South Dak	77,615	.14	.56
Texas	265,896	.48	1.55
Utah	84,990	2.5	4.06
Washington	69,127	1.1	5.9
Wyoming	97,914	2.0	6.62
Total	.....	1.63	4.58

The lands now irrigated and ultimately irrigable in the arid and semi-arid states are estimated as shown in the accompanying table, in percentages of the total land areas of those states.

Over the arid and semi-arid sections of the country water requirements of irrigated land probably average at least 2 acre-ft. per acre per annum. Probably 85 per cent of the ultimate total of irrigable land, now estimated at about 50,000,000 acres, will be served by surface waters. In that case, the total annual draft on surface waters would approximate 85,000,000 acre-ft., and the storage would be on the order of 175,000,000 acre-ft. Including all work now under construction, the total reservoir capacity of the arid and semi-arid parts of the United States is about 86,000,000 acre-ft., or half that which ultimately may be needed.

Hydro-electric power

In regard to the number of favorable power sites available, the Pacific Northwest, with its mountain ranges and heavy precipitation, stands in marked contrast to the great central plains. Even in areas of more comparable precipitation, the inherent water power varies because of differences in stream gradient, such as between the lower Mississippi and the international section of the St. Lawrence.

On Jan. 1, 1934, the total capacity of water wheels in water power plants of 75 kw. and more was 11,935,000 kw. The installed capacity of generators in hydro plants producing electricity for public use was 9,773,302 kw. This figure represents 27 per cent of the total of such central station capacity.

Development of hydro power has not proceeded solely on the basis of the availability of power sites, but has been modified and conditioned by the organic growth of the national economy, of which power is but one factor. The density and movement of population, the location of different types of industrial activity, the distribution of resources and the varying rates of technological development are but a few of the elements entering into this interplay of relationships. It is factors such as these which ultimately determine the utilization of power sites.

Undeveloped Hydro Capacity—While the United States has a vast quantity of undeveloped water power, no very detailed estimate of it has ever been made. Therefore, in attempting to reach a figure which would approximate the undeveloped water power in the country, it has been decided to limit the figure to feasible undeveloped sites. This estimate is summarized in the table on p. 173, which shows that the prime power cur-

SUMMARY OF FEASIBLE UNDEVELOPED POWER BY REGIONS

Region	Regulated 90 Per Cent T.F.[1], Kw.	Regulated 97 to 100 Per Cent T.F. Kw.	Feasible Installation, Kw.[2]	Primary Energy, 1,000 Kw.-Hr.	Cost per Kw. Installed	Costs at Plant — Mills per kw.-hr. Primary Energy	Costs at Plant — Mills per kw.-hr. Total Energy
North Pacific	10,348,260	8,565,200			[3]$63 to 115	[4]0.86 to 1.72	[4]0.80 to 1.66
South Pacific	.....	[5]3,554,000	6,873,500	.....	.....	.....	.....
Colorado	.....	2,400,000		.....	.....	.....	.....
West Gulf	.....	67,500	355,500	.....	.....	.....	.....
Southwest Miss	208,800	186,400	484,300	1,632,700	$165 to 269	3.74 to 5.26	2.70 to 3.70
Missouri River	.....	640,800	1,749,500	5,618,900	$240 up	5.00 to 9.95	.....
Upper Miss	.....	50,300	313,300	439,800	$156 up	.....	.....
Alluvial Miss	.....	0	0	0	.....	.....	.....
Ohio River[2]	.....	3,443,500	8,753,660		$118 to 274	4.29 to 9.74	
Great Lakes	.....	1,008,700	1,477,800	8,796,000	$109 to 267	[3]1.21 to 9.30	[3]1.07 to 5.90
North Atlantic	.....	474,900	2,864,800		$136 to 216	4.00 to 12.90	3.70 to 5.90
South Atlantic	.....	920,400	3,311,300	8,062,600	$129 to 242	5.10 to 8.35	3.30 to 7.33
Grand total	.....	21,311,700					

[1]T.F. = Time flow.
[2]Proposed installation not available for all projects, but at 9 projects on the main stem of the Columbia River with 3,691,000 kw. of prime power an installation of 7,306,000 kw. is feasible.
[3]Estimate based on average flow.
[4]Nine plants on main stem Columbia River only.
[5]Minimum cost is at St. Lawrence River project.
NOTE.—Unit costs are shown for only those regions in which the projects have been investigated and cost estimates prepared.

rently feasible of development, with regulated flow at a majority of the sites and with an average over-all efficiency of 75 per cent, is 21,311,700 kw.

Rural Electrification — Of the 6,200,000 farms in the United States, only 850,000 have electricity. If so-called "farms" in the suburban areas of cities are excluded, the percentage would probably drop to 10 or less. It is estimated that about 12,000,000,000 kw.-hr. of energy are utilized on farms annually, of which about 1,000,000,000 kw.-hr. are now supplied by electricity.

Water conservation by storage

Surface Storage—The greater portion of the natural runoff of streams occurs during late winter and spring. Most of it cannot be concurrently utilized, and holding back a portion of the excess flow by reservoirs for release during later months of low natural flow will increase the total usable flow of a stream several hundred per cent. In addition, reservoir regulation promotes the coordinated or multiple use of water. Therefore the utility of water resources as well as the available quantity may be increased by storage. For example, the Hinkley Reservoir built by the state of New York to supply water for the barge canal is also a source of water supply for the city of Utica and vicinity, for power production, sewage disposal by dilution, and flood reduction in the Mohawk River.

Subsurface Storage—A large part of the United States is underlaid by artesian reservoirs which, under natural conditions, contain large volumes of water under pressure. If the pressure is sufficient to deliver water at the surface or within pumping distance therefrom, it is an ideal form of natural conservation by storage.

In addition to the great artesian basins, there is throughout a large part of the United States a superficial groundwater reservoir which usually contains water within easy reach by shallow wells. The enormous extent of this groundwater reservoir may be realized from the fact that except for regulation by natural lakes, it supplies the dependable or perennial flow of all streams.

In relation to natural underground storage reservoirs, general legislation is needed (*a*) to prevent waste and (*b*) to restrict use of an amount not exceeding available supply. In some cases more drastic restrictions are needed for a period of time to restore groundwater levels and storage to natural conditions.

Academically, water for potable and domestic consumption is often considered a primary use. Practically it is a primary use only to the extent to which and when needed for this purpose. Obviously, other uses should not be inhibited, nor should large drainage basins be reserved for this purpose where only a part of their yield is required. In the humid regions a population of 100,000,000 could theoretically be supplied with plentiful water for potable and domestic uses to the extent of 100 gal. per capita per day, from the regulated runoff of 10,000 square miles. Not more than about 5 per cent of the natural water resources in the eastern part of the United States is likely ever to be required for public water supply.

Water committee's recommendations

The committee recommends, in respect to surveys, inventories and records, that in cooperation with the various states: (*a*) the topographic mapping of the United States be pushed vigorously to completion; (*b*) the present system of permanent gaging stations on all rivers concerning which records of flow are important for water resources planning, be extended; (*c*) appropriate inventory surveys of water resources of the nation be undertaken systematically under unified government auspices; (*d*) systematic, uniform land-use surveys of the country be initiated; (*e*) studies of the groundwaters of the nation be systematically pursued; (*f*) study of water supply and sanitation in relation to public health be promoted; (*g*) research in respect to water quality and standards be further promoted; (*h*) studies be made of coastal erosion and methods for its control.

It is further recommended that provision be made for an exhaustive study of the federal and state legislation needed to permit effective cooperation between federal, state, local and regional agencies in regard to the conservation and more effective use of water.

The committee recommends that provision be made promptly for surveys, studies and experiments in directive and administrative planning in selected unit areas, in terms of all their natural resources and of all their relevant economic and social conditions, with a view to promoting all phases of public welfare in such cases. Conditions in the Ozark Highlands, where water may be considered a dominant factor, illustrate the opportunity and need for efforts of such an inclusive character.

A fourth recommendation is that comprehensive and detailed studies be undertaken of large projects of water use based on drainage areas such as the Tennessee Valley.

For the advance planning of unified development of water resources over fairly long periods, the committee recommends the establishment of an advisory planning agency for coordinating the use and control of water resources in cooperation with existing and special federal and state agencies. This organization would have the following functions:

a. Discovery and formulation of desirable new projects.

b. Evaluation of projects of local or regional origin.

c. Designing the agreements and arrangements for carrying each project through to consummation.

d. Promoting combined or coordinated efforts in securing hydrologic, economic and other physical and social data.

e. Promoting standard practices and uniform legislation among political areas in their handling of water.

f. Promoting intelligent understanding of water problems and approach of proposed projects by the public.

g. Working out such special problems as the relation between benefits, cost, and contribution, and in general devising a proper order of accounting for enterprises that are essentially social in their nature.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

Selecting and Specifying Lumber

LUMBER GRADE-USE GUIDE for Soft-wood and Hardwood Lumber in Building and General Construction — Fabricoid loose-leaf; 8½x11 in.; pp. 213; halftones and tables. Published by National Lumber Manufacturers Association, Washington, D. C. $1.50.

AS THE TITLE INDICATES, the purpose of this loose-leaf book is to provide lumber users with information as to what is the best type of lumber to use for the particular type of structure they propose to put up, and also to give the user concise information as to the physical characteristics of lumber with which they have to work. The book is made up of fifteen pamphlets punched to fit a standard 8½x11-in. binder. The first is a general statement concerning characteristics of soft-wood lumber and the abbreviations used; the following thirteen sections are devoted to detail statements of the various principal kinds of softwood; and the fifteenth pamphlet deals with hardwood lumber and timber for buildings and other structures.

A Textbook on Waterworks

ELEMENTS OF WATER SUPPLY ENGINEERING—By Earle Lytton Waterman. Cloth; 6x9 in.; pp. 302; photographs, diagrams and tables. Published by John Wiley & Sons, Inc., New York. $3.50.

PROFESSOR WATERMAN'S contribution to the rapidly growing body of waterworks literature is quite frankly a textbook for students who are beginning their study of water-supply engineering. Designed to provide for classroom use a book that would cover the fundamentals of the subject, and yet not be too long to be studied thoroughly in the time available in the usual civil engineering curriculum, the book is relatively brief, but it combines with its brevity an admirably complete coverage of this wide field. By the same token, however, the discussion is confined to fundamentals, and many of the troublesome refinements of current waterworks practice are either given scanty attention or omitted entirely. This in no way detracts from the book's value for its designed purpose, but of course limits its usefulness to the practicing waterworks specialist. The book has been planned to take up each phase of water-supply engineering in the order in which it would be considered in reviewing the development of a waterworks system. Thus, general requirements, sources of supply, methods of transportation of water, treatment methods, pumping, distribution, operation, maintenance and finance are taken up in order. In other words, the water is followed from its source through the various structures and devices until it is delivered to the consumer.

Gas-Tax Status

GASOLINE TAX IN THE UNITED STATES—By F. G. Crawford. 46 pp.; 19 tables. Published by Public Administration Service, 850 E. 58th St., Chicago. Price 50c.

THIS COMPLETELY REVISED fourth edition of a pamphlet, which in its earlier editions was recognized as the authoritative compilation of facts about the gas tax, brings the story up-to-date, and tells of recent trends and developments. It covers such subjects as measures adopted to stamp out gas-tax evasion, how they have worked and how the more progressive states have drastically cut down exemption and refund claims, holding them within legitimate bounds. Professor Crawford also tells what distribution each state now makes to the cities and what the organized demands of the cities are. Figures are given on the extent to which the gas-tax revenues are increasingly being used for non-highway purposes.

Flume Design Data

THE FLOW OF WATER IN FLUMES—Technical Bulletin No. 393, U. S. Department of Agriculture. By Fred C. Scobey. Paper; 6x9 in.; pp. 99; halftones, charts and tables. For sale by the Superintendent of Documents, Washington, D. C. Price 15c.

BECAUSE sizes of flumes are of great importance from an economic as well as a hydraulic standpoint, Fred C. Scobey, of the U. S. Bureau of Agricultural Engineering, has made tests on the carrying capacities of flumes to obtain practical information that will enable engineers to design and build structures to take care of their needs. Detailed results of experiments, including formulas for flow of water in flumes, a flow classification and a discussion on problems in capacity design, are contained in the above noted bulletin, the fifth in a series. The other four relate to experiments with flow of water in irrigation channels, in wood-stave pipe, in concrete pipe, and in riveted steel and analogous pipes. Flume sizes in this study range from little structures 1 ft. wide to the Brooks Aqueduct in Canada, 20 ft. wide by 9 ft. deep and the 20-mile-long Tiger Creek conduit in California, 14x6 ft. Velocities ranged from streaming flow as low as 1.08 ft. per second through critical-flow conditions of some 11 ft. per second up to shooting flow nearing 30 ft. per second. Interior conditions covered by the study include surfaces new and old, clean and algae-coated, painted and unpainted, smooth and rough. Mr. Scobey found that long flumes, in which the anticipated velocities are slower than the critical, can be designed like any other open channels, using one of the standard formulas for uniform flow. However, the high velocities usually associated with flumes must be kept in mind. Definite provision must be made for the drop in water surface necessary to develop the high velocity, as water enters the flume from the canal or other conduit at a lower velocity. Greater freeboard is required to care for anticipated or possible waves. At the outlet transmission, the recovery of velocity head should be considered.

Skyscrapers

Reviewed by Robins Fleming
American Bridge Co., New York, N. Y.

BUILDING TO THE SKIES: The Romance of the Skyscraper—By Alfred C. Bossom. 7x10 in.; pp. 152; numerous halftones. Published by The Studio, Ltd., London, and The Studio Publications, Inc., 381 Fourth Ave., New York. $4.50.

FOR some twenty years Alfred C. Bossom practised his professsion of architecture in the United States and designed several skyscrapers. After his return to England he entered public life and is now a member of parliament. His book is written for the general reader and in nontechnical terms, but the technical reader will find much in it of interest and profit.

Mr. Bossom profoundly believes in the skyscraper for America but would hate to see them in Britain. "There they would be an architectural incongruity with no relation to social and industrial needs." Rulings in regard to "ancient lights" have often hindered the development of a property and would probably bar any proposed skyscraper.

A marked feature of the book is the arraignment of British building procedure. Of the annual building bill fully 10 per cent is literally thrown away through poor organization and obsolete practice. A single body with authority could approve or disapprove plans in about a sixth of the time now wasted in canvassing the approval of a host of local officials. All buildings in Britain, he says, take too long to erect. The advantages of a "time and progress schedule" are emphasized. Without such schedules skyscrapers in the United States could hardly have been erected. The timing to the hour so that men are not waiting for material nor material waiting for men is characteristic of the building of an American skyscraper. Britain sadly lacks such coordination in her building work.

Miscellaneous Notes on Booklets and Reprints

THE WATER JET PUMP is analysed in a pamphlet published as one of a series of University of California Publications in Engineering (Vol. 3, No. 3), University of California Press, Berkeley, Calif. Price 35 cents.

PILE TRESTLES AS CHANNEL OBSTRUCTIONS is the subject of an illustrated paper by David L. Yarnell, published as Technical Bulletin No. 429 of the U. S. Department of Agriculture. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 10 cents.

A VARIETY OF STATISTICS ON CEMENT AND CONCRETE, on street and highway mileage and on the mileage of streets and highways paved with concrete, also on highway taxes and expenditures, is contained in "Cement and Concrete Reference Book, 1934," published by the Portland Cement Association, 33 West Grand Ave., Chicago, Ill. Free upon request.

A STATE PLAN FOR MISSOURI is contained in the preliminary report of the Missouri State Planning Board, Capitol Building, Jefferson City, Mo., price $1. The pamphlet summarizes the fundamentals essential to any planning program, outlines what has been undertaken as PWA and CWA projects, and states that a comprehensive public-works program will be submitted in a subsequent report.

WATER SOFTENING is the principal subject covered in a 143-page booklet entiled "Water Supply and Treatment," by Charles P. Hoover, chemist, Water Softening and Purification Works, Columbus, O., issued as Bulletin 211 of the National Lime Association, 927 15th St. N. W., Washington, D. C. Its purpose is to provide concise information for city officials or industrialists contemplating softening installations, but it will be useful as a reference for plant operators, engineers and laymen interested in the subject. Although the booklet is sponsored by the lime interests, Mr. Hoover attempts to present data on all processes in an impartial manner.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

COMPRESSED AIR DATA—Edited by F. W. O'Neil. Flexible; 4x7 in.; pp. 394; halftones, line cuts and tables. Published by *Compressed Air Magazine*, Bowling Green Bldg., New York City. $3.

DAUERVERSUCHE AN EISENBETON-BALKEN MIT VERSCHIEDENEN STAHLBEWEHRUNGEN — By Rudolf Saliger. Paper; 6x9 in.; pp. 95; halftones, line drawings, tables. Published by Osterreichischer Ingenieur-und Architekten-Verein, Wien, Austria. Price 7M.

DYNAMIC ECONOMICS—Monograph No. 1, Cowles Commission for Research in Economics. By Charles Frederick Roos. Cloth; 7x10 in.; pp. 275; tables and line drawings. Published by the Principia Press, Inc., Bloomington, Ind.

THE ENGINEER'S YEAR-BOOK 1935—41st Annual Issue: Revised under the direction of L. St. L. Pendred. Flexible; 5x7 in.; pp. 2641; halftones, line cuts and tables. Published by Morgan Brothers, Ltd., London. 31s. 6d.

EXCESSIVE RAINFALL IN TEXAS—By A. M. Vance. Designed and Prepared by Robert L. Lowry, Jr. Paper; 8x10 in.; pp. 149; maps and halftones. Published by Reclamation Department, Austin, Texas.

MANUAL OF FIRE-LOSS PREVENTION OF THE FEDERAL FIRE COUNCIL—Paper; 5x8 in.; pp. 156; tables. Published by Superintendent of Documents, Washington, D. C. 20c.

MARKETING INDUSTRIAL EQUIPMENT—By Bernard Lester. Cloth; 6x9 in.; pp. 307; numerous charts and tables. Published by The McGraw-Hill Book Co. $3.50.

MECHANICAL WORLD YEAR BOOK 1935—Cloth; 4x6 in.; pp. 360; line cuts and tables. Published by Emmott & Co., Ltd., Manchester, England. 1/6 net.

MUNICIPALLY OWNED ELECTRIC UTILITIES IN THE UNITED STATES, 1934—Cloth; 6x9 in.; pp. 64; folding map and tables. Published by Superintendent of Documents, Washington, D. C. $1.

THE PANAMA CANAL AND ITS PORTS—Port Series No. 22 (Revised 1934). Paper; 6x9 in.; pp. 93; halftones, folding maps and tables. Published by Superintendent of Documents, Washington, D. C. 35c.

PRELIMINARY REPORT ON HYDRO-ELECTRIC DEVELOPMENT IN SHANSI, 1934—Paper; 8x10 in.; pp. 26; halftones, folding maps and line drawings. Published by China International Famine Relief Commission, Peiping, China.

PRELIMINARY REPORT ON FOUR RIVERS OF SHANSI, 1934—Paper; 8x10 in.; pp. 25; halftones, folding maps and line drawings. Published by China International Famine Relief Commission, Peiping, China.

RESISTANCE OF MATERIALS—By Fred B. Seely. Cloth; 6x9 in.; pp. 436; line drawings and tables. Published by John Wiley & Sons, Inc., New York. $3.75.

SUSPENSION BRIDGES OF SHORT SPAN—By F. H. Frankland. Cloth; 6x9 in.; pp. 128; halftones and line drawings. Published by American Institute of Steel Construction, New York. $3.50.

Letters to the Editor

San Gabriel Dam No. 1

Sir—Bids for the construction of San Gabriel Dam No. 1 received at the three openings clearly show the way contractors will increase their bid figures if the specifications require them to carry unusual risks. The San Gabriel specifications call for sound heavy rock, 30 per cent to be pieces weighing from 3,000 to 14,000 lb., with other lighter-weight percentages being stated. Payments would be made only for the acceptable rock placed in the dam, and the price covered all the costs of stripping, wasting the material not accepted, the hauling, etc.

While certain quarry sites near the dam were shown on the drawings, no exploratory tunnels had been driven at these quarries, and the prospective bidder had to determine for himself whether the canyon walls, which did not look very good, would produce the rock specified. Thirty or forty miles away there was a quarry that would probably supply the quality of rock needed.

At the first bid opening, Aug. 1, 1932, only one bid was received—$11,270,043 using Gunite facing, or $11,315,868 using a poured slab. It is known that the bidder figured on obtaining the rock elsewhere. The bid was rejected.

The set-up was changed for the second opening on Sept. 19, 1932, so bids could be offered on the entire work, or on one or more of the five or six parts dividing the job. Again the only bid received for the entire work was filed by the same bidder that bid on Aug. 1. Bids were also received on various parts of the job, but none on the rockfill schedule except as this part of the work was included in the bid offered for the entire dam—$11,268,978 using Gunite facing, or $11,236,473 using a poured face. The bid was rejected.

Before the third opening of Dec. 19, 1932, the set-up was changed, so that the bidders named separate prices for the stripping, the haul, the quarry waste and the acceptable rock from each of several quarries, with the result that seven bidders offered bids on the entire job, as the contractor no longer had to take the responsibility that the near-by canyon walls would produce the kind of rock required; also that there would not be excessive waste material handled for which no payment would be made. These improved conditions led the single bidder at the first two openings to reduce his figures to $8,767,415 for the Gunite facing and the same amount for the poured facing; the award went to a lower bidder.

The significant fact in all of this is that the sole bidder at the first two openings reduced his price over $2,500,000 for the third opening because the contract did not place so much risk on him. The amended set-up attracted more bidders and the actual construction experience seems to have demonstrated that the first bids were not too high. Seldom if ever has there been a case like this that so clearly exemplifies the postulate that "to obtain low prices the risks should be reduced."

A SURETY COMPANY

Jan 23, 1934. SPOKESMAN.

ENGINEERING NEWS-RECORD

Volume 114, No. 5.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard.

Editorial and Publishing Office at 330 West 42d Street, New York

January 31, 1935

Younger Blood

WHEREVER it is found practicable to do so, junior members are to be added to the regular committees of the American Society of Civil Engineers. This action has been taken in recognition of the fact that the younger men now have little voice in the affairs of the society. The practice of putting one junior on each standing committee already is in effect in some of the local sections and is producing good results. Its extension to the committee work of the parent society is logical. But it may be worth while also to broaden the available field by including the younger men of the associate grade. There are men in that group who, although eligible for committee membership, are seldom given an opportunity to take part in society affairs. Such men have sufficient practical experience to make their addition to any committee of considerable value.

Timely Action

REPRESENTATIVES of the highway industry who met last week at the annual convention of the American Road Builders Association took a position on federal highway policies that was encouragingly definite and constructive. The resolutions form a solid creative working program. The association will militantly oppose road-tax diversion. It will fight force-account construction and administration of road operations by other than present established agencies, and it will also endeavor to bring about revision of the hampering restrictions on hours of work and sources of employment. As presented in another column, these policy statements express fundamental principles for the sound recovery and progress of highway development that call for the support of every highway interest. If the announced policies are put into practice, they will lift roadbuilding into the position of a continuing business, from which it was cast down by the shock of business depression. The highway industry has a larger purpose than to continue to act as an unemployment relief agency; all its elements should stand together in furthering this purpose.

Not Yet a Plan

ADMIRABLY SUITED to its assigned purpose of exploring the nation's water resources, the report of the Water Planning Committee, abstracted at length elsewhere in this issue, should not be looked upon as a basis for the recommendation of a specific program of construction. The report is a factual appraisal of the water resources of the nation, together with a statement of the general principles involved in planning for water use. Properly, therefore, the report can be considered as laying the foundation only for the formulation of a national water policy, which is the next essential step toward rationalized water use. To what extent shall government seek to regulate the uses to be made of our natural waters? What is to be the extent of the national government's interest in stream pollution? How are existing private riparian rights to be modified in the public interest? These and a host of other major questions of policy must be answered with authority before any definite planning can be begun. The present report will be of inestimable value as factual background for the establishment of a rational water policy, but to attempt to make it serve as the basis of a program of construction is illogical and might easily result in bringing discredit to meritorious work.

Marine Borers Again Active

RENEWED ACTIVITY of marine borers, especially at some points along the New England Coast, was reported at recent meetings of the American Society of Civil Engineers and the American Wood Preservers Association. The activity appears to be reaching a high point just as it did in the period 1922-24, which raises the interesting question as to whether the teredo and limnoria go through recurring cycles of development. A cyclic theory would not explain why the activity is more intense in some areas and less intense in others than during the earlier period; but as sewage pollution causes a decrease in teredo attack, it may be that other changes in the coastal water of which we are not aware are responsible for the changes in intensity of attack. Rather ironically, reduction in sewage pollution in the waters around our coastal cities, such as all cities seek to obtain, results in exposing marine structures to attack by marine borers; but this risk is of course no reason for allowing pollution to continue.

Reclamation and Stream Planning

IN REPORTING on the general success and national desirability of reclamation development—irrigation of Western arid lands under federal aid—the committee appointed for this purpose last September by Secretary Ickes of the Interior Department has made three major recommendations for improved procedure that if adopted would change reclamation materially. One, designed to put settler finance on a business basis, proposes interest-bearing repayment, limited, however, to the value added to the land by irrigation. A second proposes that a fixed policy be laid down with respect to water power—heretofore a troublemaking auxiliary of many reclamation developments. The third proposes comprehensive stream-basin planning jointly by federal government and states, and adjustment of water rights on a basis of equitable balance between the several regions embraced in the basin, as a condition precedent to any further reclamation undertaking. These recommendations are far-reaching, and appear to have intimate relation to the long history of reclamation difficulties. We hope to give them full discussion on a later occasion. For the present the point of special interest is the close parallelism between the leading features of this report and the chief conclusions of the National Resources Board. Both reports strongly advocate comprehensive stream planning with a view to efficient use of the resources involved—following closely the basic principles of the Federal Water Power Act. This likeness of view gives hope for official acceptance of such policy to supersede random action. Both reports also point to the necessity for studying the distribution of benefits and allocating costs accordingly. Reclamation progress and national development is likely to be greatly promoted by careful consideration of these policy views on the part of Congress.

Toying With Recovery

THE PRESIDENT'S work-relief bill passed the House last week not only in substantially the form in which it was introduced but apparently without any effort having been made to even suggest that the money be spent and the program carried out by normal methods of contracting. Thus the process of toying with recovery continues.

If there are any conclusions from the past year's herculean efforts to bring business recovery that have gained wide acceptance, they are, *first*, that the durable-goods industries must be revived, and, *second*, that the CWA program, though a boon to retail business, accomplished exactly nothing in helping the durable-goods industries to their feet. Since various statements of the President's indicate that he also subscribes to these conclusions, the glorified CWA which his work-relief bill apparently contemplates is difficult to comprehend.

Repetition of CWA with its emphasis on direct job labor ignores the multitude of workers in mine, mill and factory and therefore ignores recovery. Repetition of CWA, even with projects so chosen as to require large quantities of materials and equipment, ignores the fact that a force-account set-up equal to the task does not exist, and that a contracting system does; recovery is again ignored. If it is deemed expedient to sacrifice the construction industry for jobs in 1935, where are the jobs coming from in 1936, if private business does not recover sufficiently to provide them?

Thus recovery continues to clash with relief. That relief has no recovery value is proved anew by Lloyd-George's denunciation of the British unemployment-assistance doles as ineffective for recovery, for his campaign in favor of a construction program derives its strength from the fact that relief payments have not reactivated the economic circulation. The British experience should be a warning to Congress that our own half-begun recovery program must not be allowed to degenerate into a relief program.

Five elements are necessary to make the new construction program a true recovery agency:

1. Fad and dream projects must be rigidly excluded, at the risk of further weakening the confidence that builds new business enterprise. Projects must be so chosen that they will not displace regular workers to make way for relief-roll men, but will provide new employment; and they must be located where the unemployment exists. They may in no case conflict with existing activities.

2. Normal construction and business procedure must be followed in carrying them out. Contractors must be called in to execute them, and force-account operation must be definitely limited to classes of work to which contracting is not applicable. The emergency program must utilize to the full all existing agencies within its scope, whether in contracting, in materials or in equipment.

3. The hand-labor fallacy must be eliminated. All work must be carried out with efficient tool and machine equipment, carrying the recovery effect all through the domain of industry.

4. Labor must be recruited on the basis of fitness, not on the basis of relief need, residence or political affiliation.

5. Wages under the emergency program must be adequate for support but less than prevailing construction wages. To this end, immediate determination of actually prevailing construction wage rates must be carried out by competent authority, most effectively by the Planning and Adjustment Board.

Forceful evidence of the importance of these policy fundamentals was accumulated during the year of PWA and CWA operations. That the great PWA program failed to advance recovery, and that its work-relief methods played a large part in the failure, is today generally recognized. Continued confusion of relief and reform objectives with the primary recovery purpose will lead to equal failure of the new program proposed in the blanket bill now before the Senate.

Flood Control at Los Angeles

TWENTY YEARS AGO the Los Angeles region experienced a devastating flood which aroused public thinking on the problem of controlling run-off from the severe local storms in the mountainous area behind the city. The first decade following was occupied in stimulating public opinion to the point of backing a state measure to establish a flood-control district. The Los Angeles County Flood Control District, governed by the board of county supervisors, was thereupon formed. The second decade witnessed the building of a number of dams and a considerable volume of channel improvement, but a striking failure to complete necessary control works on the San Gabriel River, the largest and potentially most dangerous stream in the county. Today, any review of the situation reveals two outstanding conclusions: first, the flood menace has not been relieved, but is even more acute as a result of phenomenal growth in the area; second, the failure in the proper prosecution of the program can be laid directly at the door of the county supervisors, or, more precisely, of the act that makes the county politicians the directors of the district.

There should be no discounting the seriousness of the flood hazard in the Los Angeles metropolitan area, regardless of the past years of subnormal precipitation, with their soporific effect on public interest. It is inevitable that record-breaking storms will again occur.

This condition emphasizes the need for a comprehensive plan, based primarily on hydrologic and topographic data, but coordinated with economic factors. Further, the increasing value of water continually changes the picture to place more and more emphasis on conservation as a correlated effort, which also demands comprehensive planning. Continued regional growth adds to the flood hazard each year, and only by a comprehensive program of protective works, vigorously prosecuted, can the Los Angeles area insure against a disaster that would overshadow the destructive flood of 1914.

The lack of progress on the program, particularly on the San Gabriel River, reviewed last week, must be ascribed directly to the district organization, which places control in the hands of county supervisors, with all the attendant trappings of county politics. For years, the engineering and technical approach to the problem has been biased by political intrigue. Even at the very outset, the rejection of the program of a four-to-one majority report of an engineering board and the acceptance of the one-man minority report provided a foretaste of the flood-control results that the people of Los Angeles County were to receive, and at no time thereafter was sound engineering analysis permitted to establish a dependable basis for solving the problem.

The situation today is both grave and urgent. Its technical difficulties are by no means small, but they are quite secondary to the insurmountable obstacles that lie in political management. These must first be cleared away.

CURRENT NEWS

Work-Relief Bill Being Considered by Senate Committee

(Washington Correspondence)

The Administration's $4,880,000,000 works bill, having passed the House Jan. 24, is now before the Senate. Admiral Christian J. Peoples, Director of Procurement of the Treasury, was among the first to testify. In his previous testimony before the House Committee, he presented figures based on a comprehensive study of relief activities made for the Administration. An average security wage of $50 per month is contemplated under the new program, he said, citing percentages of total costs of various types of work which would be reflected in direct labor. Most of the types of work mentioned in the President's message run from 30 to 40 per cent. A single lump sum appropriation is required to meet changing conditions of unemployment as they arise, the admiral stated.

In the House

As passed by the House the bill would retain for the President the power to disburse the huge fund much as his fancy dictates. A significant deletion from the original draft was the power to postpone as far as June 30, 1937, the termination of any government agency. Had this been retained in the bill, it would have been possible to continue such units as NRA without specific legislation.

All attempts to earmark specific projects or types of work failed under the gag rule. Even the general work objectives (slum clearance, rural electrification, roads, and other items in the President's message and in the original draft of the bill) were removed so that the program now vaguely covers federal and non-federal work.

By a close vote of 131 to 159, an amendment proposing that prevailing local wage rates be paid was rejected. The proposal, offered by Representative Connery of Massachusetts, House exponent of 30-hr. week legislation, would have upset the policy of encouraging men to accept private work by making relief lower paid. Efforts to ban work competitive with private enterprise were heavily overridden.

Research on Cement Gelatin Aided by Grant to M.I.T.

A grant of $1,000 has been made to the Massachusetts Institute of Technology's chemical engineering department by the National Research Council for research in the gelatin of cement. The chemistry and physics of the hardening process will be investigated under the direction of Dr. L. S. Brown of the department in cooperation with the department of civil and sanitary engineering. It is expected that the research will occupy about a year.

San Jacinto Tunnel Contractor Declines to Surrender Contract

Formal refusal to surrender work on the 12.7-mile San Jacinto tunnel project on the Colorado River Aqueduct has been made to the Metropolitan Water District of Southern California by representatives of the Wenzel and Henoch Construction Co. The company, on Jan. 15, was notified (*ENR*, Jan. 24, 1935, p. 141) by the district that the company's $7,339,100 contract for the San Jacinto tunnel had been suspended because of unreasonable and unnecessary delay.

The Metropolitan Water District has filed an application with the federal court for an order restraining the contractors from continuing with work on the tunnel and from interfering with the district taking it over. The application, according to James H. Howard, general counsel for the district, is returnable Jan. 28.

Arizona to Draw New Contract For Colorado River Water

At the meeting of representatives of the Colorado River basin states held at Phoenix, Ariz., Jan. 14-16, Arizona agreed to draft a new contract setting forth its requirements for rights to water from the Colorado River and submit it to another conference. When the new document is drawn Arizona will notify W. R. Wallace, chairman of the Utah Colorado River Commission, who was made chairman of the Phoenix conference, and he will issue a call for another meeting of state representatives to be held in Salt Lake City.

The Phoenix conference, in spite of its failure to provide definite settlement of the problem of allocating the water of the Colorado River, was considered successful because of the atmosphere of frank discussion. The delegates aired all sides of the issue and a number of proposals and counter proposals were made, particularly between states in the lower part of the basin, which resulted in the conclusion to have Arizona draft a new contract.

Appeal for Work by Contract Urged by Chamber of Commerce

An appeal for consideration of the advantages of the contract method in public works construction was made in a letter sent by Henry I. Harriman, president, Chamber of Commerce of the United States, on Jan. 28 to Senator Carter Glass. Senator Glass is presiding over the Senate Appropriations Committee which examines the Administration's work relief bill. In cases where the contract system cannot be used, the chamber urges that a system of cost accounting be used.

Part of the letter states: "Since it is peculiarly desirable that money being spent for employment should produce as much employment as possible, the contract method should be used, we submit, as most conducive to economy. In so far as the contract method is not followed, we believe cost accounting should be required, both because it will be conducive to economy and will disclose true costs of projects undertaken."

Coldwater River Floods 300,000 Acres Above Marks, Miss.

SERIOUS local floods centering around the town of Marks, Miss., and inundating 300,000 acres have followed record high water on the Coldwater River caused by a precipitation of more than 12 in. on its watershed area during a 3-day period ending Jan. 22. The high water will have no appreciable effect on the Mississippi River. The following information was furnished by Major L. E. Oliver, district engineer, U. S. Engineers, Vicksburg, Miss.

The Coldwater River reached a crest height of 21 ft. at Coldwater, Miss., on Jan. 21, with a discharge of 60,000 sec.-ft. This is a 2½-ft. higher crest than the maximum of record established in 1930, which had a discharge of 40,000 sec.-ft. This record runoff resulted from a 12½-in. rainstorm over the 1,400 sq.mi. of Coldwater River drainage basin for the three-day period prior to Jan. 22, with 8 in. falling in Memphis. The resulting floods now prevailing in the upper Yazoo delta, principally in the counties of Quitman and Tunica in northern Mississippi and moving south into Tallahatchie county are considered 50 per cent greater than the flood of 1930. Coldwater River, east of the delta area, flows through the hills of northern Mississippi and has runoff characteristics typical of flashy, hill streams.

Flooded areas

The flood on the Coldwater River is expected to prolong the high water stages of the Tallahatchie and Yazoo Rivers rather than increase their height. The area flooded above the town of Marks, Miss., totals about 300,000 acres and an additional area south of Marks amounting to 250,000 acres is expected to be flooded during the high water stage.

Flood control works in the area have been inadequate for even small floods and have proven entirely inadequate for floods of the magnitude experienced in 1932 and the present high water. The 1932 flood in this area caused about $400,000 damage, much of it being the loss of agricultural crops. The present flood, coming more suddenly and with greater force, has caused a larger loss, principally to railroads, bridges, houses and other property rather than to agricultural crops. The agricultural losses from the present flood will be restricted mainly to livestock and stored feed crops. An approximate estimate of the flood damage done up to Jan. 28 is $2,000,000. Government engineers are surveying the flood damage done in the area.

IN WASHINGTON

By Paul Wooton
Washington Correspondent

Formal resolutions by the American Road Builders Association urging the use of the contract system in connection with the work relief program and the earmarking of the fund to be used for road work, so that planning may proceed, are receiving impressive support on Capitol Hill. This may influence administrative agencies even if these conditions are not made a matter of law.

An inconsistency in New Deal policy is seen in the insistence upon the direct hiring of labor for the work-relief program. Construction is carried on by a large number of relatively small concerns. It is pictured as the last stronghold of the small unit in business. Yet this industry that has no trusts, that is made up of little men, is being eliminated from the work-relief program.

Nothing has been revealed as yet to indicate that the work relief program is more than a glorified CWA. Since it involves five times the expenditure made for CWA, there is fear that a mess five times as great may result.

Liberalization of direct loans to industry is meeting with favor in Congress. "Reasonable" instead of "adequate" security allows much wider discretion on the part of the lending agency. More loans to contracting companies seem likely, since more funds for purchase of equipment may be loaned under the revised bill.

A surprisingly large vote was cast in the House of Representatives to require payment of the prevailing wage on work relief projects. An amendment to that effect lost by only 28 votes.

Submission of legislation aimed at the control of holding companies has been delayed due to disagreement as to which agency of the government should administer the proposed law.

Amounts recommended by the Administration for unemployment benefits and for old age pensions apparently will be written into law.

In an effort to compose disputes before they develop into strikes Secretary Perkins has invited the heads of state federations of labor to a conference she is sponsoring in Washington.

Los Angeles Flood Control Work May Be Placed Under New Board

A bill prepared for submission to the California legislature would provide for a complete change in the administration of the Los Angeles County Flood Control District, removing it from the jurisdiction of the county board of supervisors and placing it under a board of five independent directors. According to the tentative plans of the bill there would be one flood control district director for each supervisorial district within the flood control district. The board of supervisors of the county would be required to select the five directors for the flood control district from a list of ten names, two for each district, submitted to the supervisors by the executive head of the University of California at Los Angeles.

Permanent Resources Board Favored by President Roosevelt

"A permanent national resources board, toward the establishment of which we should be looking forward, would recommend yearly to the President and the Congress priority of projects in the national plan," stated President Roosevelt in his message to Congress on Jan. 24 transmitting to that body with his approval the report of the National Resources Board. He added, "This will give to the Congress, as is entirely proper, the final determination in relation to the projects and the appropriations involved."

In referring to the bill now before Congress appropriating $4,000,000,000 for public works, the President stated in his message that a substantial portion of that sum would be used "for objectives suggested in this report."

The National Resources Board's report, together with that of the Water Planning Committee is characterized in the President's message as constituting a foundation for a permanent policy of orderly national devleopment. The water committees' report is abstracted at length in this issue, pp. 169-173.

Advisory Committee Appointed For Los Angeles Flood Control

Without relinquishing its authority over flood control funds or policies the Los Angeles County Board of Supervisors has appointed an advisory committee of ten prominent Los Angeles county citizens to act with the board on flood control matters. The committee is composed of county residents selected by the supervisors, each supervisor naming two members of the committee, which will serve without pay. H. C. Legg, chairman of the board of supervisors, stated that the board feels that the existence of such a committee will do much to restore the public confidence in the administration of flood control affairs.

Stream Pollution Study by National Resources Board

Intensive consideration of the problem of stream pollution was undertaken by the National Resources Board this week with a view to defining an effective policy for the future. Recent reports by the board and the Mississippi Valley Committee put great emphasis on the present confusion in regulating disposal of domestic and industrial wastes arising from jurisdictional and other legal problems. For a detailed review of the problem H. R. Crohurst, sanitary engineer of U. S. Public Health Service, has been assigned to the National Resources Board to prepare a report covering detailed phases of the problem within 60 days. An advisory committee has been appointed composed of W. B. Bell, U. S. Biological Survey, Col. Glen Edgerton, Corps of Engineers, A. C. Fieldner, Bureau of Mines, Elmer Higgins, Bureau of Fisheries, Thorndike Saville, Water Resources Section of the National Resources Board, R. E. Tarbett, Public Health Service and Abel Wolman, Maryland State Department of Health.

The National Resources Board does not expect to arrive at any simple solution of the problem which involves both diversity in agencies and methods for enforcement of statutory and administrative restrictions and technical questions relating to domestic sewage treatment and treatment and recovery of industrial wastes.

California Biennium Road Fund Set at $61,285,000

For the biennium 1935-37, California has approved a list of highway projects that includes $37,807,000 for new construction, $15,215,000 for maintenance, $2,450,000 for engineering and administration and $5,812,000 for allocation to cities. The sources from which these funds are derived are as follows: State's portion of 2-cent gasoline tax, $46,500,000; motor vehicle fees, $5,300,000 and federal aid, $9,485,000.

Proposed Legislation Chief Concern of A.G.C. in Annual Convention

FACED with uncertainty as to the course of the four-billion dollar public works and relief bill, with its threat of day-labor operations, and confronted with some 200 other bills of interest to the construction industry, already introduced in Congress, the Associated General Contractors opened the three-day session of its sixteenth annual convention in Washington on Jan. 28 with a sober realization of the number of serious problems to be considered.

In the first session President N. F. Helmers outlined the situations confronting general contractors today, stressing the legislative factors. Foremost in the early discussions was the relief bill. Mr. Helmers stated that before the convention adjourned it must prepare for presentation to President Roosevelt definite and sound recommendations as to the administration and operation of this bill. At the time of writing of this report the committee appointed to prepare such recommendations had not yet reported to the general meeting.

The A.G.C. is ready and willing to do its best to assist the Administration to bring about real recovery, according to Mr. Helmers' remarks at the first session. He pleaded for an attitude of regard for the interests of the country at large rather than a selfish interest of contractors alone in consideration of the public works bill.

Address by Willard Chevalier

Speaking before the general meeting, Willard Chevalier, vice-president of the McGraw-Hill Publishing Co., declared that proposals to carry out the four-billion-dollar emergency relief program by day labor is the most serious threat ever to confront the construction industry. "To see clearly the ultimate significance of this proposal," he declared, "we must remember that the construction industry has been built up over many years to meet the special needs of our national economy. It includes a vast number of independent organizations of

(Continued on p. 181)

Service Records of Treated Timber Outlined At Wood Preservers Meeting

AN IMPRESSIVE array of records of treated timber, chiefly in railroad service, was presented to the American Wood Preservers Association at its annual meeting held in New York Jan. 22-24. The records of railroad construction were presented by two railroad engineers and one mine manager, guest speakers at users' day, a regular feature of the association meetings in recent years. Other sessions were devoted to operating and technical problems of timber treating, to preservatives, to fire retardant wood, termite exposure test reports, and reports on the use of creosoted wood in residences and other buildings. On Wednesday a trip was made to the plant of the Protexol Corp., at Kenilworth, N. J., to witness a test on fire-proofed wood.

Trestles and piles

The Southern Pacific was a pioneer in the use of creosoted timber, according to George R. Rear, engineer of bridges, Pacific Lines, in a paper presented by Elmer T. Howson in his absence. That company's first treating plant was built in 1889, and the company had used some treated timber before that time. By 1895 it had ten miles of trestles of treated timber in service, many of which are still in service. Others, built in the early nineties, were too light structurally but were sound physically when dismantled.

Mr. Rear laid particular emphasis upon the need for preframing timber before treatment. On the other hand, he stated that his company had had little trouble with decay entering through bolt holes bored after treatment, provided the bolts remained in place.

Treated ties

The Burlington also was an early user of treated timber, according to H. R. Clarke, engineer maintenance of way. Its important records relate to the use of preservative treatment for cross ties. The Burlington began treating ties in 1899, treating about 16,500,000 ties by the Burnettizing process, ½ lb. of zinc chloride per cubic foot of wood, and 3,250,000 by the Card process, ½ lb. zinc chloride and 3 lb. of creosote per cubic foot. Since that time nearly 62,000,000 ties have been treated, about half each process. By 1908 experience had shown that the zinc chloride treatment gave satisfactory service in the semi-arid regions west of the Missouri and the combination of zinc chloride and creosote in regions of heavier rainfall.

The use of these preservative treatments increased the average service life from 10½ to 18½ years and has resulted in a decrease of tie renewals of nearly 1,000,000 ties per year. Meanwhile tests on other processes were in progress which in 1930 resulted in a decision to adopt the Reuping process, using 50 per cent each by volume of creosote and petroleum with a retention of 8 lb. per cubic foot of wood. Using tie plates, with the ties adzed and bored before treatment, it is expected that the average tie life can be increased to 25 years.

Experience with treated ties and timber in mine service was outlined by F. F. Jorgensen of the Consolidated Coal Co., Fairmont, W. Va. Experience there has shown that in mine service the treated tie will have a life of 20 years, about seven times that of an untreated tie.

Additional information on the life of treated ties was contained in the report of the committee on tie service records.

Creosoted wood in buildings

As the result of questionnaires covering 273 buildings in which creosoted wood was used for sills, floor joists, sub-floors, floor nailing strips or similar purposes where the wood is concealed from view, the special committee on the use of creosoted wood in residences and other buildings presented a report with recommendations for such use.

Attacks on marine structures

In a session devoted to the marine-borer problem along the north Atlantic seaboard, New York City's century of experience with teredos and limnoria was reviewed by Francis J. O'Keefe, chief engineer of the city dock department; the serious nature of present marine-borer attacks around Boston was outlined by W. F. Clapp; and the general aspects of the marine-borer problem and the methods of protection were discussed by Hermann von Schrenk.

Mr. O'Keefe cited a report of 1832 as the first one to mention "worms" eating piling. In an 1856 report it was said that the teredos were becoming less destructive than formerly because of increased sewage in the harbor. When the dock department was formed in 1870, teredos were apparently non-existent, and protection by creosoting was not generally required. At present, dock department maintenance gangs are required to turn in any specimens of teredo-eaten timber, so that areas requiring protection may be known. Only in such areas is creosoted timber required. However, on account of the city's program for cleaning up the pollution in the harbor, the dock department is working on a comprehensive plan for a more general requirement for creosoting.

Mr. Clapp, who is the principal biologist for the National Research Council in its investigation of teredos in Boston harbor, reported a great increase in destructive work along the New England coast during the past few years. At the Commonwealth Pier, 20 per cent of the wood piling was removed by marine-borers in seven years, from 1926 to 1932, and 20 per cent more of the wood was destroyed during the past two years. At the Army Base Pier, 50 per cent of the wood in the piling is gone.

Mr. von Schrenk strongly urged creosoting as a protection against marine borers and outlined precautions in timber selection and in fabrication and erection of structures, to avoid injuring the timber and thus exposing it to attack. Timber should be framed before creosoting; field-cut surfaces should be treated immediately and covered with a tarred cloth; resinous knots should be cut out and replaced with creosoted plugs; wood with a large amount of sapwood, up to 3 in., should be specified; only air-seasoned timber should be used; only the full-cell method of creosoting should be permitted; and 20 lb. of creosote per cu.ft. should be the minimum specified for northern waters, with greater amounts farther south.

Construction League Adopts A Working Program

At its general assembly in Washington, D. C., Jan. 26, the Construction League of the United States voted, with 17 of its 22 member organizations and also three state construction leagues represented, to adopt the program of objectives and activities presented by special committee report at the construction conference held at Knoxville, Tenn., Dec. 7, 1934 (*ENR*, Dec. 13, 1934, p. 772). The program as adopted varied only slightly from the committee's draft published in *Engineering News-Record*, Dec. 20, 1934, p. 791. Some criticism was raised of the clause approving "prevailing rates of wages" and it was voted to submit it to a special committee for a rewording that would reconcile the differences.

The major reports of the meeting were those on codes, state construction leagues, legislation and housing laws. S. F. Voorhees, reporting on codes, stated that of the construction codes 21 were now approved and 6 were before the NRA for approval. Means had been set up by the code authority for securing a census on employment. At present thirteen area agreements had been adopted and many others were now before the NRA for consideration.

As current business the assembly voted an amendment to the regulations which provided for the election of an executive committee. The following officers were elected for this year: general chairman, John P. Hogan, vice-president, American Society of Civil Engineers; first vice-chairman, Malcolm Pirnie, past-president, American Water Works Association, and general secretary, John H. Zink, vice-president, Heating, Piping & Air Conditioning Contractors National Association.

Eastman Proposes ICC Control Over Road and Water Transport

Railroad Coordinator Eastman, in his report to the President and to Congress, proposes that federal regulation of water carriers and of highway motor carriers be vested in the Interstate Commerce Commission, that the ICC be reorganized and that the reorganization include a permanent Coordinator of Transportation. Mr. Eastman rejects all pretentious plans for consolidation of the railroads into a few systems and defers endorsing government ownership in favor of giving private management a further chance to put its house in order under an extension of government control which will include control of the railroads' competitors by highway and waterway. The report outlines a method for government acquisition of the railroads by interim rental pending final settlement, and operation by a government controlled corporation directed by five public trustees. Under the present abnormal conditions, however, he believes that government ownership would be dangerous.

To expedite needed financial reorganizations of the railroads, Mr. Eastman would carry Section 77 of the Bankruptcy Act a long step further by waiving consent of two-thirds of a road's creditors as a prerequisite to reorganization if the court finds that the plan is fair and equitable.

Proposed Legislation Reviewed At A.G.C. Convention

(Continued from p. 179)

engineers, architects, contractors and subcontractors, each composed of individuals employed on the basis of special skill or fitness and coordinated into highly efficient and competent staffs. This has been done by private enterprise using private capital, and from time immemorial these organizations have operated under the spur of keen competition, either professional or industrial. Their prosperity and survival have been directly dependent upon their ability to produce and deliver the greatest value at the lowest cost.

"Speaking particularly of the contracting group, be it observed that it embodies an investment of many years of toil and millions of dollars of capital on the part of some of the most courageous, aggressive, productive and resourceful men that American industry has ever produced. These men have built up this contracting industry by sheer capacity and have maintained it, even in the grief of the past few years, in the belief that they embody normal construction practice, that eventually they would be needed once again by American construction, both public and private, and when that day came normal American methods and institutions still would prevail in the conduct of construction work.

"Any procedure so ill-considered as now to destroy or cripple this organized construction industry would result not only in the loss of human values and the capital that have been invested in it, but also in an irreparable shock to the confidence of all those industries that have been developed around and are tributary to the processes of construction."

Codes considered

The question of codes, their continuation and the disposition of sub-divisional Chapters IIA, IIB and IIC received serious consideration. Area agreements, regarded as wholly unsatisfactory so far, were also discussed.

In a report of the legislative committee of the association, headed by George B. Walbridge, the public works bill was of chief concern. If the proposed program is carried out by force account methods at least 40 per cent of those now employed in construction will be thrown out of work, the report stated. The task of spending four billion dollars demands careful thought, declared Mr. Walbridge, and there is time for a real study before the program goes into effect, supposedly at the start of the next fiscal year, July 1. The committee recommended the adoption of an amendment to the House Resolution on the bill that "Wherever possible in the planning and execution of such program, full advantage should be taken of the facilities of private enterprise."

Many other bills affecting contractors were reported by the committee, some regarded as detrimental, others as beneficial. Among these are a proposal to extend the effect of the undesirable Bacon-Davis prevailing wage act to include federal-financed highway work; a bill to require contractors to hire local citizens, state citizens, citizens at large and then aliens in that order of preference on public works; bills designed to prevent contractor chiseling by forcing the naming of subcontractors and to require that general contractors perform at least 60 per cent of the work themselves.

CWA and FERA Attacked

In a report on government competition by day labor methods, B. L. Knowles attacked CWA and FERA procedure as wasteful and extravagant, and declared execution of the proposed public works program by the same methods would be disastrous to not only the contracting industry but to the country at large. He reported on day labor operations in the Smoky Mountain National Park, at the Reedsville, W. Va., subsistence homestead project, the Beltsville, Md., agricultural experiment station and Norris village on the TVA project, declaring all were examples of "waste, inefficiency and extravagance."

A report of final sessions of the meeting will be given in these pages next week.

Harry de B. Parsons Dies; New York Consulting Engineer

Harry de Berkeley Parsons, consulting engineer in New York City for almost 50 years and advisor to various municipal departments for many years, died at his home in New York City Jan. 26. He was 73 years old. Mr. Parsons was also well known in the field of mechanical engineering, having served as professor of steam engineering at Rensselaer Polytechnic Institute from 1891 to 1907.

Born in New York City, Mr. Parsons received his B.S. degree at Columbia in 1882 and an M.E. degree from Stevens Institute of Technology two years later. For several years he served on railroad engineering work in Texas, and then turned to the field of mechancial engineering. There followed 16 years of teaching experience at Rensselaer Institute (1891-1907) and after leaving the institute he held the title Professor Emeritus of Practical Engineering.

During his many years of private practice he served New York City as consulting engineer to the street cleaning department during five administrations, was chairman of the commission on street cleaning and waste disposal and a member of the Metropolitan Sewerage Commission, 1908-1914. His work also included the handling of numerous foundation problems, including undermining work.

He was president of the Institute of Consulting Engineers in 1926 and a member of the American Society of Civil Engineers. Mr. Parsons received the Rowland prize in 1925 and the Croes medal in 1930.

New York Joins in Urging Federal Gas Tax Repeal

In a memorial passed by the New York state legislature urging the repeal of the 1 cent federal gasoline tax, the thirteenth state has been added to the list of states requesting abolition of this federal excise. The twelve other states whose legislatures have requested Congress to leave this form of taxation to the states are Arkansas, Florida, Michigan, Mississippi, Montana, Nevada, New Jersey, North Carolina, Ohio, Oklahoma, Oregon, and South Dakota.

Personals

LT. COL. H. J. WILD, Corps of Engineers, U. S. Army, has been transferred from his post at Fort Lewis, Wash., to the position of district engineer, Seattle, Wash.

HON. GROTE STIRLING, recently appointed Minister of National Defence in the Canadian government, is the first member of the engineering profession to attain cabinet rank. Mr. Stirling was an engineer in private practice.

CHARLES W. KLASSEN, assistant sanitary engineer, Illinois State Department of Public Health, has been appointed acting chief sanitary engineer to fill the vacancy caused by the recent death of H. F. Ferguson.

LOUIS L. DRASLER, engineer for the Ohio state highway department on PWA and FERA work, has been named division engineer of the department to succeed John J. Jaster, who was recently made director of state highways.

J. L. BEATTIE, senior engineer in the service department of Cleveland, Ohio, has been appointed first assistant city engineer. Mr. Beattie has been an employee of the department for nearly 20 years. The position was made vacant by the recent death of Ray Miller.

WILLIAM M. SPANN has resigned from the position of senior engineer-examiner in the office of the state PWA engineer of Missouri to become president of the Tuttle-Ayers-Woodward Co., an engineering organization at Kansas City. Mr. Spann had been with the state PWA office since it was organized in August, 1933.

A. LINCOLN FELLOWS, recently retired as senior irrigation engineer, U. S. Bureau of Agricultural Engineering, has opened an office as consulting engineer in Denver, Colo., specializing in water supply, irrigation and related problems. He is associated with Ralph I. Meeker.

JAMES A. MCCRORY has been appointed chief engineer and vice-president of the Shawinigan Engineering Co., Ltd., Montreal. Mr. McCrory, a graduate of Pennsylvania State College, 1907, went to Canada in 1910 and joined the present organization in 1916. He has served as office engineer for the company since 1918.

RICHARD E. HEARTZ has been made assistant chief engineer of the Shawinigan Engineering Co. He has been on the engineering staff of that company for 15 years.

A. N. GOLDBERG, engineer and contractor, New Orleans, has been made drainage engineer of the New Orleans Sewerage and Water Board to fill the vacancy created by the promotion of Alfred Theard to the position of general superintendent. Mr. Goldberg has been connected, at various times, with the Louisiana Highway Commission, Orleans Levee Board and the New Orleans city engineer's office.

MARTIN H. REGAN, for 11 years engineer in charge of road construction and maintenance in Cattaraugus County, N. Y., has been transferred to Niagara County. JOHN PHELAN, state engineer in Chautauqua County for the past two years, moved to Mr. Regan's former position. STANLEY ORSER has been transferred to Chautauqua County where he was formerly stationed. These changes were brought about by the recent death of A. G. Earle, highway engineer for the state in Niagara County.

Obituary

HORACE FORD, assistant engineer of buildings, Baltimore, Md., died suddenly at his home on Jan. 25 at the age of 57.

ARTHUR G. VAN BUREN, contractor at Stoneham, Mass., died in that city Jan. 23 at the age of 70. He was active in the construction of the Harvard University Stadium and the subway at Cambridge, Mass.

J. E. HOLT, chief surveyor, Bureau of Engineering, Los Angeles, Calif., died suddenly at his home in that city Jan. 21. He was 52 years of age. Mr. Holt had served for 32 years on many of the city's large engineering projects.

EDWARD H. HARNETT, city engineer and director of public service, Long Beach, Calif., died Jan. 20, at the age of 46. He had been city engineer for the past two years and recently had taken over the additional office of director of public service.

CLAYTON P. CANNON, civil engineer, died at his home near Baltimore Jan. 17. For a number of years he was vice-president of the Bennett Construction Co., and for the past two years had served with the construction department at the United States Proving Ground, Aberdeen, Md.

N. A. KELLY, sales manager in New York City of the Universal Atlas Cement Co., died at his home in Forest Hills, L. I., Jan. 16. He was 51 years of age. During his early years he was associated with two well known contracting companies, Lee & Casey, Pittsburgh, and T. A. Gillespie Co., Pittsburgh and New York.

ALFRED L. HARTRIDGE, president and general manager of the A. L. Hartridge Co., New York City, died of a heart attack on a Pennsylvania railroad train near Steubenville, Ohio, Jan. 23. He was 50 years old. Mr. Hartridge was also a vice-president of the Stone & Webster Engineering Corp. He was a graduate of the Georgia School of Technology in 1904, and his first engineering work was on railroad construction, both in Alaska and Central America. He joined the Stone & Webster Engineering Corp., working as construction engineer, construction manager and vice-president on many of its projects. When the A. L. Hartridge Co. was organized in 1929, as an affiliated company of Stone & Webster, Mr. Hartridge became president and general manager, transferring his headquarters from Boston to New York that year.

CONSTRUCTION STATISTICS OF THE WEEK

HIGH PRIVATE AWARDS are responsible for the engineering construction total for this week of $24,922,000. Private awards total $9,111,000 and public awards, $15,811,000, of which $3,219,000 is federal work and $12,592,000 state and municipal. This is an increase of 55 per cent over the high private total last week. Federal work is down 56 per cent and state and municipal work is up 4 per cent from last week's volume.

Industrial buildings are largely responsible for the high private figure, $7,089,000; waterworks are higher at $2,340,000 and sewerage is up, at $1,304,000. Other classifications of work run below last week: public buildings, $3,805,000; commercial buildings, $975,000; bridges, $484,000; streets and roads, $4,580,000 and earthwork and drainage, $3,010,000.

The larger projects include: steel mill for Carnegie Steel Co., McDonald, Ohio, $2,000,000; copper refinery for Consolidated Copper Mines Corp., Kimberly, Nev., $3,000,000; police headquarters, Buffalo, N. Y., $420,000; outlet and intake works at East and West Portals and lining Moffat Water Tunnel intake shaft and wye, Gilpin and Grand Counties, Denver Water Dept., Colo., $973,000; Schedules 1, 2, 8, 9 Malheur River Syphon & Dead Ox Syphon on North Canal, Owyhee Project, Ore., $607,000; oil circuit breakers and other equipment for Boulder Dam, Boulder City, Nev., $959,000; 15,000 tons 100 lb. rail for Tenn. Coal Iron & R.R. Co., Nashville, Tenn., $500,000; 15,000 tons tie plates and fastenings for Norfolk & Western Ry. Co., Norfolk, Va., $500,000.

In spite of state and municipal bond sales of $7,495,000, the total new capital figure slides back $750,000, due to large rescissions and reductions in PWA allotments and changes from loan and grant allotments to grant only.

CONTRACTS

(Thousands of Dollars)

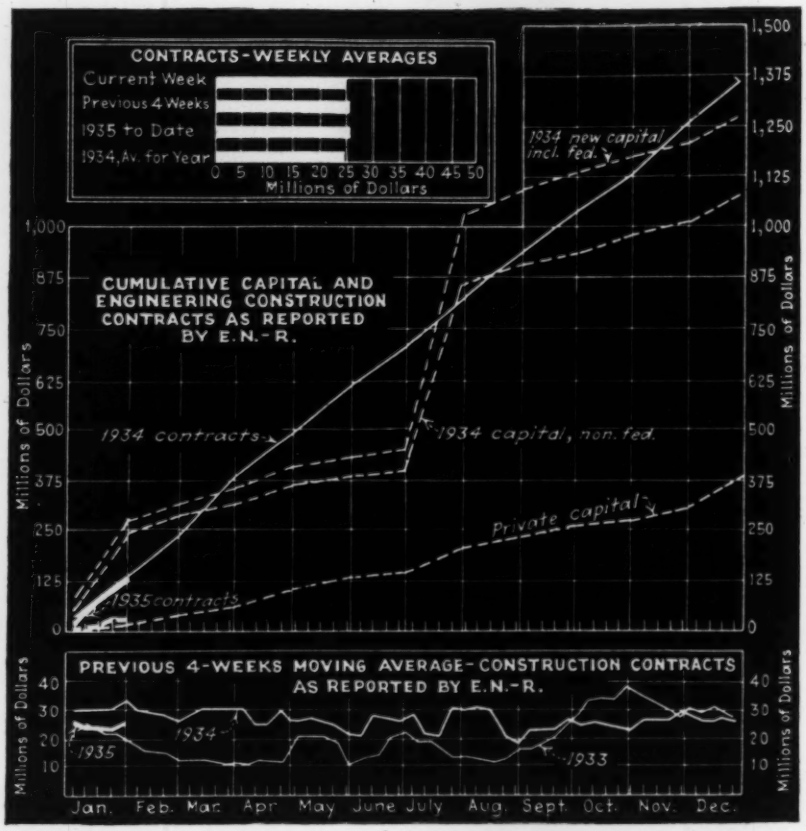
	Weekly Average Jan. 1934	Prev. 4 Weeks	Week Jan. 31 1935
Federal Government	$15,532	$5,879	$3,219
State and municipal	14,321	15,864	12,592
Total public	$29,853	$21,743	$15,811
Total private	3,542	3,592	9,111
Week's total	$33,395	$25,335	$24,922
Cumulative to date:			
1934	$175,236,000	1935	$126,264,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1934	Week Jan. 31	Cumulative
State and municipal	$7,495	$34,219
PWA allotments, S&M	—9,531	—9,152
RFC loans, S&M	....	.....
Corporate issues	....	.....
PWA allotments, private	1,286	3,652
Total, Non-Federal	—$750	$28,719
PWA allotments, Federal Constr.	....	2,531
Total new capital	—$750	$31,250
Cumulative to date:		
1934	$283,685,000	1935	$31,250,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction.

INDEX NUMBER

E.N.-R.- Cost	1913 = 100	1926 = 100	E.N.-R.- Volume	1913 = 100	1926 = 100
Jan., 1935	**198.72**	**95.52**	**Dec., 1934**	**105**	**46**
Dec., 1934	201.86	97.03	Nov., 1934	115	50
Jan., 1934	191.26	91.94	Dec., 1933	116	51
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56